SCIENTIFIC AMERICAN

No. SUPPLEMENT 909

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Scientific American Supplement, Vol. XXXV. No. 909.
Scientific American, established 1845.

NEW YORK, JUNE 3, 1893.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

SIR RICHARD OWEN.

THE long illness and great age of Sir Richard Owen had prepared us for the announcement of his death, on December 18, aged eighty-nine. No name more illustrious in the world's annals appeared in the crowded obituary of the year 1892. Many were the men of science who then passed to the majority, some of them also at a great age, as Sir George Airy, the Astronomer Royal, and Professor Adams, the joint discoverer with Leverrier of the planet Neptune. The two greatest of the poets of the Victorian age, Whittier and Tennyson, who died near the same time, claimed wider popularity. But to those who know the history of the century Richard Owen stands out as the name of most honor and distinction in the domain of science.

A whole generation having come to the front since Owen withdrew from public life, to live in comparative retirement, there are many who have almost forgotten his name and his work. But the chiefs of science, the "men of light and leading," knew and honored the grand old man. When his death came, there was an instant and spontaneous desire that his dust should be laid in Westminster Abbey. Happily for the dean—who knew less about Owen than about Tennyson or Browning, and who had expressed his unwillingness to receive any more dead bodies into the crowded soil within the walls—it was announced that, by his own desire, the patriarch of science was to be laid in Ham Church by the side of his wife, who was there buried.

The quaint and picturesque cottage in Richmond Park, "Sheen Lodge," where he resided during the last forty years of his life, was assigned to him by the Queen after the exhibition of 1851, of which he was one of the commissioners, and to the success of which he largely contributed. The intention was to give another larger mansion, but at the moment there was a question as to whether the property belonged to the crown or to the King of Hanover. Sheen Lodge became vacant before the rights of the crown to the larger house were settled, and Professor Owen told Prince Albert, as he then was called, that, if allowed to choose, he would greatly prefer the lodge in Richmond Park. The arrangement was soon made, with the approval of the Queen, who had always had warm personal regard for the professor.

In this charming retreat Professor Owen found a congenial and comfortable home. Gradually the grounds were planted with all manner of trees, till it became quite a model northern *arboretum*. He was also a great grower of roses. On the green lawn of the lodge, overlooking Richmond Park, he received many a distinguished visitor, and enjoyed the company of his friends. Humble tenants shared the protection and kindness of the good master. His presence in the garden, when without strangers, was the signal for flocks of birds to greet him, settling on his head and shoulders; and he well knew the tastes and habits of these unimprisoned pets and pensioners. He was as observant as Gilbert White of Selborne, or his friend and neighbor Mr. Jesse. Indoors he was almost always busy. His one favorite recreation was music, in which he had the finest taste. His own instrument was the violoncello, which it was a treat to see the philosopher handle.

Throughout his last long illness, many incidents were from time to time recorded, showing the honor in which he was regarded, and the affection borne to him. With the most distinguished of his neighbors at Richmond and Kew he had always been on terms of intimacy, and the Princess Mary of Teck, with her family, were unwearied in their attentions. It was this that led the Prince of Wales, near the end, through them to seek to have a last interview. This gracious and considerate action was also manifest in the message which was sent from Marlborough House, also through the Princess Mary, to convey the Prince's regret and sympathy after death. The message was thus worded:

"Will you kindly express, in my name, my deepest sympathy with Sir Richard Owen's daughter-in-law at the loss of her distinguished father—such an old and valued friend of mine? ALBERT EDWARD."

The telegraphic message sent by the Queen was equally prompt and warmly expressed. She knew how deep was the Prince Consort's affection for Sir Richard Owen, and she had often been herself present when in olden days the professor came to give instruction to her children in natural history. Owen used to tell of his first visit to the palace for this purpose. When Prince Albert and the boys, with others in attendance, were in the room, he noticed that the door was left open, and he afterward learned that the young Queen was sitting to listen to the exposition, while the Prince was pointing with the rod to the diagrams on the blackboard. She knew the learned lecturer better before long, and it was by royal invitation that Owen accompanied the Prince and Princess of Wales on their Nile voyage and first visit to Egypt.

Having not long ago, in 1888, at the time of his retiring from official life, given in the *Leisure Hour* a memoir of Professor Owen, with a pretty full notice of his chief works, accompanied by a portrait kindly sent by himself, it is not our purpose here to enter into details. Our desire is only to lay a wreath on the tomb of one so loved and honored. The scientific journals have given copious descriptions of his various books and writings, the mere catalogue of which would fill pages of our magazine. A list of them, with dates and all particulars, will no doubt form an appendix in the official "Life," which is announced to be undertaken by Sir Richard's grandson, the Rev. R. S. Owen.

"His contributions to literary and scientific periodicals alone," says Miss Agnes Crane in her interesting memoir in the *Leisure Hour* in 1883, "number nearly four hundred. Many of these are important memoirs embodying new facts and valuable discoveries. They are to be found in the 'Philosophical Transactions' (of the Royal Society), in the journals and magazines of the Linnæan, the zoological, the geological, and other societies, in the 'Reports' of the British Association; and in numerous other publications."

One of the earliest memoirs was on the "Nautilus," published by the council of the Royal College of Surgeons, when Owen was only twenty-seven years of age. His collaborator in this work was Dr. George Bennett, of Sydney, who was fortunate enough to procure a specimen during a cruise in the Polynesian Seas. George Bennett must now be of extreme age, having been one of the earliest settlers in New South Wales, and his "Zoological Researches" were begun at the same date as those of Richard Owen. At intervals he has paid visits to the old country, and we welcomed him in our office only a few years since. He was one of Owen's oldest friends.

Born on July 20, 1804, Richard Owen in early life

SIR RICHARD OWEN, F.R.S., LL.D., K.C.B.

entered the navy; but when peace came, in 1814, the hopes of advancement for the youthful "middy" were clouded. He returned to school, and in due time studied medicine under a surgeon at Lancaster, his native town. Thence he went to Edinburgh, where he studied for two years, and going to London he was a pupil of the famous Dr. Abernethy, who quickly recognized the genius and noted the industry of the young anatomist. After spending some time at Paris, studying comparative anatomy under Cuvier, then at the zenith of his fame, he returned to London, and was recommended by Abernethy to assist Mr. William Clift, F.R.S., then engaged in sorting and cataloguing the collections of John Hunter, which had been purchased by government, and transferred to the Museum of the Royal College of Surgeons. In 1853 he married Miss Clift, the daughter of his predecessor as Conservator of the Museum, and she shared for many a year the delights of the lovely home which he soon after received by royal kindness in Richmond Park. The use of this house, Sheen Lodge, is, we understand, continued to Sir Richard's daughter-in-law during her life.

During all the period of his duties as Conservator of the Museum, and subsequently when appointed Hunterian Professor at the College of Surgeons, Fullerian Lecturer at the Royal Institution, Professor of Paleontology at the Royal School of Mines, and finally Superintendent of the Natural History collections in the British Museum, an office expressly created for him by the urgent wish of Prince Albert, and his influence with the trustees, scarcely a year passed without the appearance of original works on a great variety of subjects.

Some of these were more than mere scientific treatises, but were of national importance. He was one of the commission on the health of towns, and a second commission on the health of the metropolis. Many results followed the reports of these commissions, as well as that on the meat supply of London, which led to the removal of old Smithfield market, and the new centers of supply, with other public and sanitary movements. He worked in this cause along with the late Sir Edwin Chadwick and Sir Lyon (now Lord) Playfair. He was one of the commissioners for the great exhibition of 1851. But his greatest public service most would consider to be the establishment of the Natural History Museum at Cromwell Road, South Kensington.

In 1881 Professor Owen attended the jubilee meeting of the British Association at York. He had been president of the association at the Leeds meeting in 1858. The only survivors of the illustrious presidents of the first twenty-five meetings, at the York jubilee, were Airy, at Ipswich in 1851, and the Duke of Argyll, at Glasgow in 1855. Almost all the early members had passed away, and it was pleasant to see Owen at York, one of the last veterans of the "Old Guard." We saw him during the days of the meeting, and on the Sunday, in the grand cathedral, he was among the crowded audience who listened to the admirable sermon preached by Dr. Fraser, the Bishop of Manchester. Owen wore his black cap, as in the portrait now given.

In the business of the meeting he presided over Section D (zoology), selecting as the topic of his opening address, "The Genesis of the Natural History Museum at South Kensington," a subject which had occupied his attention for a quarter of a century, with very beneficial results to the nation and to science.

The transference of the national biological collections from Great Russell Street to South Kensington was one of the chief public services of his life. It was a long and arduous task to accomplish this, which now seems so natural and necessary a movement. The removal of these collections from the overcrowded galleries of the old British Museum had been often urged by the trustees and resisted by the government on economical grounds. After many adverse votes, year after year, Sir Richard Owen at length succeeded in getting the assent of the House of Commons to the purchase of the land and the erection of the museum at South Kensington. He had been appointed superintendent of the natural history department in the old museum as long ago as 1856. Not till 1871 was the first grant toward the building of the new museum voted by Parliament. Owen lived to see the completion of the new house, and he soon after retired and resigned his appointment in 1888.

In his last official year, while occupying the position of superintendent of natural history in the old museum, he was indefatigable in every variety of useful service. Men of science of all classes sought his aid and his counsel, and many a traveler was urged by him to send objects of interest and taught how to collect and preserve them. He gave lectures to scientific students, and on Saturday afternoons to workingmen. We can see him, big bone in hand, his tall frame and broad shoulders dominating the crowd, and his kindly face beaming with intellect as he sketched the structure and habits of the extinct animal of which it once formed a part, and carrying the eager and interested circle of listeners with him as he told the story of the earth's inhabitants before man lived on its surface. He was by nature a *raconteur*, and he knew how to bring his marvelous store of scientific experience to the level of a popular audience.

He delighted in arranging and displaying the treasures of biological science for which he had at length obtained a new and worthy home. Once when he had shown a party of distinguished visitors through the museum, introducing them to the different galleries and pointing out their contents and intended purposes, an American lady exclaimed, "Why it is just like a cathedral," thus characteristically expressing her delight and sense of wonder. "Madam," the professor replied, speaking with reverence and emotion, "it is a temple where everything speaks of the glory of the Lord."

He had proclaimed the same sentiments forty years ago in a popular lecture delivered before the Young Men's Christian Association, at Exeter Hall, giving a lucid exposition of some natural history facts, yet also animated throughout by the reverent spirit of the religious philosopher. An anecdote was told in the *Times* by a clergyman who said he had met the professor at dinner thirty years before, and was impressed with the kind trouble taken by the learned man to give information and to reply to inquiries made by him, then only a young curate, on the scientific question in which he was interested. On rising to leave the table he added as a last remark, "But, after all, what is the greatest of these discoveries compared with the simplest truth which you are teaching your poor people from day to day?" It was the thought and word of a true Christian philosopher.

In Richard Owen there passed away one of the line of the truly great men of science who have maintained the harmony of the works of nature and the words of revelation. Sir Isaac Newton was the leader of this band, wisest interpreter of God's works and reverent student of God's word. Herschel and Dalton, Brewster and Faraday, Sedgwick and Forbes, were among the many who kept up the "philosophical succession"

in days before the "eclipse of faith" in our age of agnosticism, unbelief and materialism. Nevertheless, to see and to adore God in nature is still the position of the highest men in science. Owen, the pupil of Cuvier, held the same views, and never stooped to depreciate the "argument from design," as taught by Paley, and by the authors of the Bridgewater Treatises, such as Whewell, Chalmers and Sir Charles Bell. Lord Kelvin and Sir George Stokes need alone be named among the living representatives of "the old school," of which Sir Richard Owen was a noble example. He remained to the last ever a humble, modest and devout searcher after truth in every department, while so many were mistaking theories about material things for true wisdom and philosophy. Here is the concluding paragraph of his work on the "Homologies of the Vertebrate Skeleton": "In every species ends are obtained, and the interests of the animal promoted, in a way that indicates superior design, intelligence and forethought, in which the judgment and reflection of the animal never were concerned, and which, therefore, we must ascribe to the 'Sovereign' of the universe, in whom we live and move and have our being."

So much has been said about his researches in anatomy and natural history, that we prefer to mention here papers on "The Antiquity of Egyptian Civilization," written for the *Leisure Hour*, one object of which was to correct the received opinion that the building of the great pyramids marked the beginning of Egyptian civilization. Professor Owen showed from their construction that evidences existed of skilled systematic quarrying operations, displaying, as Sir John Hawkshaw, the celebrated engineer, president of the British Association, said, "a degree of perfection in all the different branches of the art of construction." The limestone, of finer texture than the rude nummulitic limestone of which the Sphinx was formed, was brought from the Arabian bank of the Nile and conveyed skillfully to the opposite or Libyan shore. The red granite or Syenite was brought from Syene or Assouan, and shaped by art such as has never since been seen in Egypt, under Roman or Mohammedan rule. The highest order of scientific skill, both in engineering and architecture, are apparent. The director general of the ordnance survey, Major General Sir Henry James, in his notes on the great pyramid in 1869, as quoted by Owen, remarks of the passages or galleries in the interior of the pyramid, that "their inclination, which is just the 'angle of rest,' is particularly well chosen, when we consider that these stone masses would have to slide down into their position. With a greater inclination it would have been difficult to guide the blocks in their descent, and with a less it would have been difficult to move them. The great masses are accurately hewn just to fill and to fit into the mouth of the passage, so as to bar unauthorized access to the royal tomb." "His must be a cold nature," says the professor, "who can view unmoved all these constructions and contrivances, majestic in their seeming simplicity.

"The beginning of that civilization," he goes on to say, "which had culminated in a creed, a ritual, a priesthood, in convictions of a future life and judgment, of the resurrection of *the* body, with the resulting instinct of its preservation—an instinct in which kings alone could indulge to the height of a pyramid, these are not the signs of an incipient civilization."

In a letter to the editor of the *Leisure Hour* dated May 10, 1876, he says:

"There are about 100 pyramids more or less recognizably preserved—all orientated, and in the main built on the intention of resisting time and conserving the carcass within—other intention can now be logically inferred from the whole premises. Cheops' happens to be the largest; the next to it, Cephrenes', is the best preserved. If a man were to moon about the relations of present measures to old cubits, etc., he might work out an *intention* differing from that he would sink into from the like work on Cheops' pyramid.

"The Hebrews were not a nation when Cheops reigned, any more than the Assyrians, but were wandering, fighting, and groping their way thereto, the which was taught them by the wholesome discipline they received, when made slave hunting grounds by Thotmes and others, who captured gangs and brought them to Egypt, whence returned slaves introduced some of the light they got from their task-masters. Solomon, contemporary of Sheshouk, shows the development of the Hebrews as a nation.

Yours sincerely, RD. OWEN."

The allusions are to discussions about the antiquity of Egyptian civilization, which was far anterior to the time of the Hebrews as a nation. Whether this early knowledge of art and science, and the possession of knowledge of a higher sort—"all the knowledge of the Egyptians," such as Moses is said to have possessed—whether this was the relic of primitive truths conveyed to Egypt by those who migrated from the earlier settlements of divinely taught men; or whether it arose by a development, necessarily slow, and requiring countless ages to achieve—these are discussions requiring larger light and more perfect exploration. Owen was ever prepared to seek truth, free from every prepossession. Accepted *interpretations* of Scripture may have to be modified, when read in the light of natural science and inquiry; but a true philosopher, as Owen was, never can lose hold of the revelations of divine truth on matters above and beyond the domain of physical research.

In a note written March 12, 1878, referring to a brief memoir of Robert Were Fox, F.R.S., which had appeared in the *Leisure Hour* he says: "This notice of a most esteemed and very old Cornish friend, Robert Were Fox, I keep as a cherished memorial of a true Christian man." Those who knew Robert Fox, of Falmouth—his noble character and beneficent deeds—will understand how Owen loved him and lamented his loss.

After the death of his wife, an aged sister came to the lodge, and was the devoted companion and comforter of the widower. How attached they were may be seen in the following characteristic note, dated Sheen Lodge, Richmond Park, March 29, 1876:

"Dear Dr. Macaulay: Whatever shortcoming your too good appreciation of my MS. may have made me feel, was more than made up by the unexpectedness of the return I had the agreeable surprise to receive this morning.

"It greatly added, collaterally, to the comfort of my old sister, who had been grumbling for two or three mornings because I didn't eat my egg. I have been a little off my feed lately, but when I opened the packet and showed her the really excellent and truthful pictures of Egypt in the beautiful book you have so kindly sent, I said I think I can manage my egg this morning, and she was comforted. Very truly yours,

RD. OWEN."

Sir Richard had an only son, who predeceased him; but his declining years, after this sad affliction were comforted by the devoted care of his daughter-in-law, Mrs. William Owen, and the bright presence of his grandchildren. The eldest of these, the Rev. R. S. Owen, M.A., we understand, has undertaken to write the life of his grandfather. He is a man of culture and accomplishment, whose early training was at the Wick School, Brighton. In the scientific part of the work it is probable that he will seek suitable co-operation, but the personal and domestic details cannot fail to be deeply interesting. It will be based on a diary, kept by his grandmother, and Sir Richard was latterly in the habit of dictating to his grandson "Recollections," which will have the charm of an autobiography, for a large period. Above all, there is the correspondence, extending over most of his long life, and which must afford ample materials. To his last years Sir Richard continued to write letters, and some of the latest that we have seen are as full of thought and of kindness as ever, and written in the same clear and beautiful hand which marked all his manuscripts, whether for the press or for private correspondence. Let the biographer take time and not be urged to premature publication of a record of the life and works of one whom Humboldt called "the greatest naturalist of his age."

We had almost forgotten to mention that Sir Richard Owen possessed nearly every honor and distinction which it was possible for a man of eminence in science to have. The Royal and the Copley medals of the Royal Society, the Wollaston medal of the Linnæan; the honorary fellowship or membership of almost every English or foreign learned society; the highest degrees of the universities of Oxford, Cambridge, Edinburgh; orders of merit and crosses of honor from all the chief courts and nations in the civilized world. The C.B. conferred in 1872, followed by the K.C.B., most gratified his loyal and patriotic spirit.

Since this was written, the meeting at the rooms of the Royal Society, Burlington House, proposing a suitable memorial to Sir Richard Owen, has taken place. H.R.H. the Prince of Wales presided, and was supported by a noble array of all the men best known in science. The speech of the Prince was as admirable in statement as it was genial in spirit. Lord Kelvin, Professor Huxley, the Duke of Teck, Sir W. Flower, Mr. Sclater, Lord Playfair, and all the speakers vied in doing honor to the memory of one whom they regarded as worthy of perpetual remembrance. It is arranged that a statue is to be placed in the hall of the South Kensington Museum; and we hope that this memorial which is to adorn the Natural History Museum will, to use the concluding words of the Prince of Wales, "be worthy of a great sculptor, and of the great man that it represents."—*Leisure Hour.*

WHY BACILLI ARE SO SMALL AND WHENCE THEY GET THEIR ENERGY.

By G. JOHNSTONE STONEY, F.R.S.

SOME bacilli, *e. g.*, some of the nitrifying bacilli of the soil, are said to be sustained by purely mineral food, while they furnish ejecta which contain as much potential energy as their food, or more. If this be the case, they must be supplied with a considerable amount of energy to enable them to evolve protoplasm and the other organic compounds of which they consist, from these materials. Now, many bacilli are so situated that this energy is certainly not derived from sunshine, and it is suggested that it may be derived from the gases or liquids about them.

The average speed with which the molecules of air dart about is known to be nearly 500 meters a second—the velocity of a rifle bullet; and the velocity of some of the molecules must be many times this, probably five, six, or seven times as swift. We do not know so much about the velocities of the molecules in liquids as of those in gases, but the phenomena of evaporation and some others indicate that they are, at least occasionally, comparable with those of a gas. Accordingly, whether the microbe derives a part of its oxygen or other nourishment from the gases or from the liquids about it, it is conceivable that *only the swifter moving molecules* can penetrate the microbe sufficiently far, or from some other cause are either alone or predominantly fitted to be assimilated by it.

Now, if this be what is actually taking place, the adjoining air or liquid must become cooler through the withdrawal from it of its swiftest molecules; and in compensation, an amount of energy exactly equivalent to this loss of heat is imparted to the microbes, and available for the formation within them of organic compounds.

It is further evident that if this be the source of energy upon which bacilli and cocci have to draw, the minuteness of their narrowest dimension will be of advantage—probably essential to them. Presumably it would be limited only by such other necessary conditions as may forbid the diminution of size being carried beyond a certain point. The diameter of a bacillus is frequently as small as half or a third of a micron, which brings it tolerably well into the neighborhood of some molecular magnitudes.

The transference of energy here suggested may be what occurs, notwithstanding that it does not comply with the second law of thermodynamics, which states that heat will not pass from a cooler to a warmer body unless some adequate compensating event occurs, or has occurred, in connection with the transference. This law represents what happens when the vast number of molecular events (which are the real events of nature) admit of being treated statistically, and furnish an *average* result. It, therefore, has its limits; and the communication of energy from air to minute organisms, which is described above, is an example of a process which is exempt from its operation; since this treatment is supposed to be brought about by a *discriminating* treatment of the molecules that impinge upon the bacillus, of precisely the same kind as that which Maxwell pictured as made by his well-known demons. It, therefore, belongs to the recognized exception to the second law of thermodynamics, viz., that which occurs in the few cases in which we can have under observation the special consequences of *selected* molecular events, instead of, as on all ordinary occasions, being able to measure an *average* outcome only from *all* the molecular events in the portion of matter we are examining.

If some bacilli—those which live on mineral food—obtain their whole stock of energy in the way here indicated, it may be presumed that all bacilli get at least a part of what they require in the same way.

The motions of an individual molecule do not from instant to instant conform to the second law of thermodynamics, although the law may apply both to the average of the motions of a single molecule taken over a long period of time and to the average of the simultaneous motions of vast multitudes of associated molecules. As regards *molecular* motions (the motions within a solid, or motions within a fluid that do not produce currents in the fluid), the millionth of one second is a long period.—*Proc. R. Dublin Soc.*

A CURIOUS PLANT.

(*Welwitschia mirabilis.*)

THE welwitschia, a low woody plant, most singular in shape and mode of growth, was discovered in 1860 by Dr. Welwitsch on the dry, sandy plateaux near Cabro Negro, in Western Africa. It was first designated by the name of *tumboa*, which was believed to

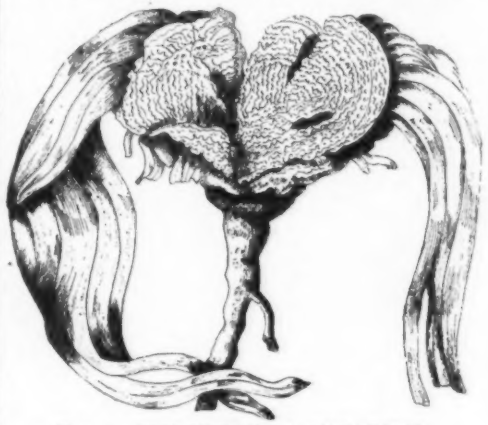


FIG. 1.—WELWITSCHIA MIRABILIS.

be that by which it is known to the natives; but this word, it appears, is applied generally to all plants that have a short, thick, woody trunk or rhizome. It has therefore been named after its discoverer by Dr. Hooker, who has shown that, notwithstanding the anomalies by which it is characterized, it forms a genus of the order Gnetaceæ. In its first youth, its two original cotyledonay leaves appear to grow considerably and extend horizontally in opposite directions, raised but little above the surface of the sand, while the intervening stock thickens and hardens and assumes an obconical shape, flattish at the top and rapidly tapering below into the descending root. As years go on, the original pair of leaves, having attained their full size and a hard, tough, fibrous consistence, do not die away, but gradually split up into shreds. The woody mass which bears them rises very little higher, but increases horizontally both above and below the insertion of the leaves, so as to clasp their base in a deep marginal slit or cavity; and every year, from the

FIG. 2.—FRUIT OF WELWITSCHIA.

upper side at the base of the leaf, are developed several short flowering stalks. These are erect, dichotomously branched, jointed stems, from six inches to a foot in height, bearing a pair of small opposite scales at each fork or joint, and each branch terminated by an oblong cone, under the scales of which are the flowers and seeds. These cones are angular and of a brilliant carmine color.

The result is that the country is studded with these misshapen table-like or anvil-like masses of wood, whose flat tops, pitted with the scars of old flowering stems, never rise above a foot from the ground, but vary according to age in a horizontal diameter of from a few inches to five or six feet; those of about eighteen inches diameter being supposed to be above a hundred years old, still retaining their leaves, ragged, indeed, and shortened by the injuries of time, but which in their full vigor extend to a length of six feet. The flowers appear to be of two kinds—females, with naked ovules like those of *Gnetum*, and hermaphrodites, showing a higher and more complex type of structure, connecting gymnospermous with angiospermous dicotyledons.

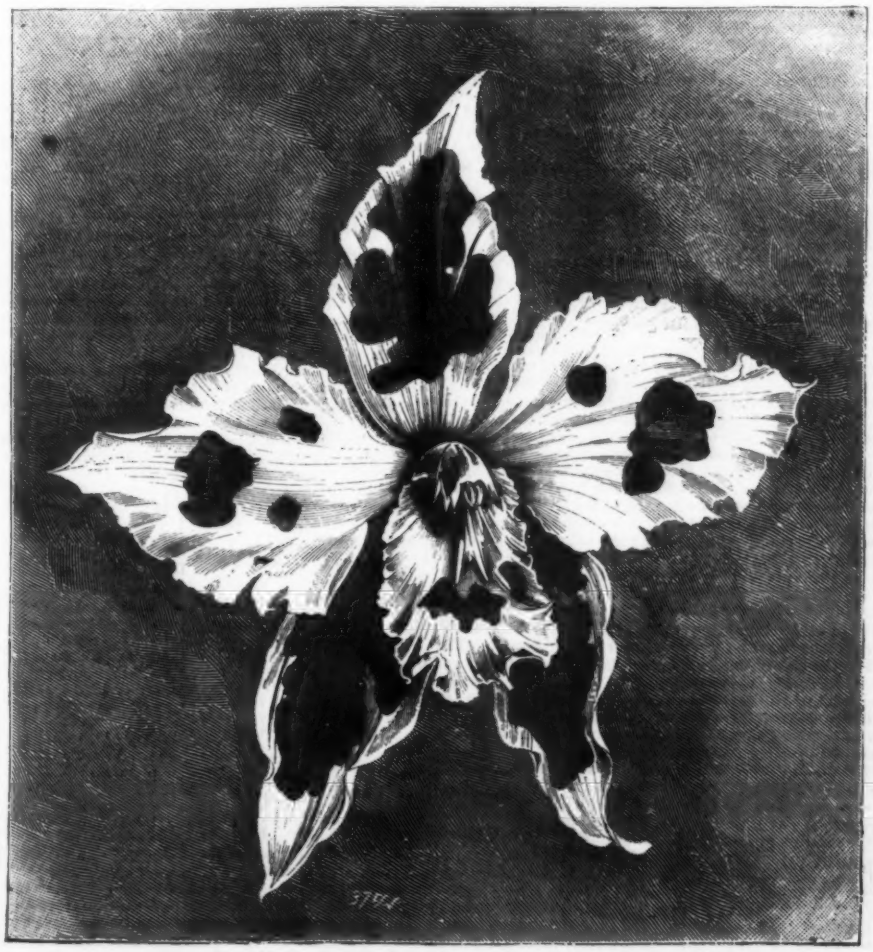
Dr. Welwitsch found these misshapen monsters, deeply sunk in the soil with their middle-sized roots, in considerable quantities at Cabro Negro (15° 4' south lat.), on the dry plateau of the coast of Benguela, which is covered with loose sandy rough rubble, and from 300 to 400 feet above the level of the sea. A little north of this place, at Mossamedes, in the vicinity of the Nicolas River, on the little Fishbay (at 14° 20' south lat.), Monteiro found it at a later period in a perfectly similar situation on quartzose schistose soil; and Mr. Baines and Mr. Anderson in Damara-land (between 22° and 23° south lat.), in the neighborhood of Whalefish Bay, in a district in which not a drop of rain ever falls. The distribution of this most remarkable plant, which calls to mind some vegetable relic of a creation long since past, falls between the fourteenth and twenty-third degrees of south latitude, as far as at present ascertained. It is well known to the natives. The crown, when divested of its leaves, resembles so closely the cracked surface of an old *Polyporus igniarius* that it might, on a superficial view, be taken for a fungus.

ODONTOGLOSSUM CRISPUM NOBILIUS.

THIS magnificent variety of Odontoglossum crispum is, undoubtedly, one of the finest of the many good forms of that beautiful species, and it is not surprising it should be regarded as one of the greatest treasures in the odontoglossum house in the Dell gardens. The flowers are of exceptional size, measuring, when fully developed, 3½ inches in breadth and 4 inches in depth, and, as shown in the figure given herewith, the sepals and petals are of great breadth. Both sepals and petals are pure white; the sepals have a large irregular blotch of a rich chestnut red color, the petals are elegantly frilled and similarly blotched, but less boldly; the labellum white, chestnut red at the base, the crest yellow. O. crispum nobilius was presented to public notice for the first time at the orchid conference held by the Royal Horticultural Society at South Kensington, and was submitted by Mr. Ballantine to the orchid committee of the society on February 9, 1892, when it had a certificate of the first class conferred upon it.—*The Gardeners' Magazine.*

A GARDEN AT BROADWAY.

HERE is a charming garden engraved from an oil painting by Mr. Alfred Parsons, in possession of the editor, and showing a border of summer flowers, mostly large annual poppies, which have lately become so popular. It shows well a type of garden not uncommon in the country towns of England, and which are in design far more charming than many pretentiously laid out gardens.



ODONTOGLOSSUM CRISPUM NOBILIUS.

A GARDEN AT BROADWAY, ENGLAND.

Common sense and simplicity have some chance in these little gardens, which are not laid out by a man who comes with a regulation plan in his pocket to adapt to every situation. People do what they like, and in the end the result is much more artistic than the ordinary "first-class" garden, with its vases, steps, etc. There is no room for a small edition of the Crystal Palace gardens, fountains, etc., and so we get something that a man can draw, paint, and remember with pleasure. This garden, which we have not had the pleasure of seeing, is, we believe, in possession of Mr. Frank Millett, and is in a beautiful village in Worcestershire.—*The Garden.*

LORD RAYLEIGH ON SOUND.*

LORD RAYLEIGH recently delivered a series of afternoon lectures at the Royal Institution on sound, and said that the course he intended to adopt was to deal chiefly with those facts which admitted of experimental illustration possible to be given in public, also to deal with points of theory not obtainable in books readily accessible. He then caused a bell to ring in an atmosphere of hydrogen, when it gave a faint sound, which grew stronger as common air was made to replace the hydrogen gas. Sir John Herschel, who, said the speaker, had done such good work that his name should not be mentioned without the highest respect, had made a mistake as to the theory of this fact; he thought that as there was a mixture of gases, the hydrogen attempted to interfere with what the air wanted to do. Sir George Stokes had given the real explanation; in hydrogen the length of the sound wave is four times greater than in air, so the bell is four times smaller in hydrogen relatively to the wave length. It would seem at first sight that if a vacuum were only good enough, the sound from a bell in it would cease, but if he said so it would be wrong, for sound could be sent through the ether, in spite of the best vacuum that Mr. Crookes or Professor Dewar could produce. An experiment could be imagined in which a magnet was caused to make 100 or 200 revolutions per second inside a vacuum, and by means of a coil of wire outside connected with a telephone, the sound could be heard.

Gases are not essential for the transmission of sound. It will pass, for instance, through wood, as set forth in the following table:

Velocity of Sound in Wood.

Name of wood.	Along the fiber.	Across the layers.	Along the layers.
Pine	10,910	4,611	2,605
Oak	12,622	5,086	4,229
Elm	13,516	4,665	3,324
Poplar	14,050	4,600	3,144
Acacia	15,467	4,840	4,436

The effect of making sound pass along a bar of wood is much the same as if a speaking tube be used. For

* From the London *Engineer*.

instance, 36 ft. below the floor of the theater a musical box was playing, and in contact with it was a rod of wood, of which the upper end came through a hole in the floor Whenever he put an empty box on the top of the rod to act as a sounding board, all present could hear it playing. When he removed the box the sound ceased, because, without the box, the greater part of the sound was reflected back again down the rod. A stretched string or wire, with a sounding board at each end, will convey sound upon the same principle.

Sounds may be classified, and those which are most suitable for investigating are musical; they can be continued with uniformity for any length of time, and present other advantages; in fact, it is only about musical sounds that much is known, exact knowledge being considerably limited to this class of sound. In musical sounds the vibrations are performed in a given time; they have the character of complete periodicity, after a certain interval of time everything occurs over again as during the first period of time. Galileo first discovered that with any particular musical sound the number of vibrations in a given time is a constant, and this is a principle of the utmost importance.

The speaker then showed that a musical sound could be produced by a sufficiently rapid succession of puffs of air; he employed a revolving disk with a horizontal axis, driven by multiplying gear; near the circumference of the disk was a series of holes at regular intervals apart, and passing close before the orifice of a pipe from which air was steadily issuing. The perforated disk moved 6¼ times faster than the handle by which the instrument was driven, so that the time of rotation of the lower wheel as compared with that of the upper wheel, combined with the knowledge of the number of holes in the latter, enabled the number of puffs of air producing any particular musical note to be counted. When another sound, made by a tuning fork, was brought to the same pitch as that given by the puffs of air, it was known that the number of vibrations of the fork in a given time was the same. He then exhibited the siren, the well known acoustical instrument made upon the same principle, and explained its method of working.

Lord Rayleigh said that some of the most important discussions upon sound have forced upon its students the idea of "phase," which means the part of a vibration in which a body is at any particular time; for instance, the moon is a vibrating body in a sense, and we have the four phases of the moon. When two tuning forks of the same period are vibrating, so as to be in the same phase at the same time, the air is condensed and rarefied by each at the same time, and the sound is louder. When the waves made by one fork are half a wave length behind those made by the other fork, the phenomenon known in music as "beats" is produced, and this has somewhat inaccurately been called the "interference" of sound.

He described a method of obtaining two or more sources of sound in perfect unison, and in the same phase at the same time. This is done by taking tuning forks having the same rate of vibration, and keeping them vibrating by means of electromagnetic adjuncts with a make-and-break arrangement, consisting of a dipper of platinum working into mercury, so as to give a periodic electric current. The forks, in perfect unison, should be used in the open air when experimenting, to avoid reflections.

To show, so far as the lecture theater would permit, that it is possible to get two sounds to completely neutralize each other, Lord Rayleigh took the column of air in the vessel, K, Fig. 1, as one resonator, and the air in the vessel, A, as a second resonator; the ends of the prongs of the vibrating tuning fork are represented at H H. The two air resonators were each tuned to the same pitch as the fork, but they were in opposite phases, so that the one neutralized the sound made by the other. When one of them was cut off, by means of a piece of card placed in the position indicated by the dotted line, N, the full musical sound was heard; it was the same when the piece of card was placed in position indicated by the dotted line, W; but when the two resonators were allowed to act together, there was silence.

Next he altered the pitch of one of two forks by loading it with wax; they then sometimes aided each other's effects, and sometimes neutralized each other's effects, producing what is known as beats in music; beats mark the time in which one vibrating body gains or loses over the other. If the time of vibration of one

FIG. 1

fork be known, by means of these beats it is possible to ascertain the time of vibration of the other fork; for instance, if there are ten beats in ten seconds of time, there is one vibration per second more or less between the two forks; if the period of one fork be known to be 256 per second, then the other, as indicated in the way just stated, must be either 255 or 257; by taking some wax off the fork of known period the beats became slower, showing that the forks are then more nearly in unison, which proves that the rate of vibration of the other fork is 255 per second. In cases in which great accuracy is required in these computations, the beats are slowed as much as possible; he had worked with them at Cambridge at as low a speed as three a minute.

The lecturer then exhibited an experiment by means of what is known as Blackburn's pendulum, in order to show that a body is capable of having two independent kinds of vibration of different periods. This pendulum had two independent points of suspension, by means of the two wires, A K, Fig. 2, coming down from their attachments to the roof of the theater. They were joined at W to the single wire, W N, which carried a funnel filled with dark sand falling in a steady stream from its neck, so as to draw a pattern on a great sheet of white cartridge paper upon the floor. This mode of suspension made the length of vibration of the

FIG. 2

pendulum four times longer in one direction than in the other direction, and caused it to trace out an elegant combination of curves upon the paper.

Lord Rayleigh continued that it is difficult to get a good obstacle or screen opaque to sound. The best obstacle he knew of was a haystack of large size; not one of the little ones built in some parts of the kingdom. There should be no trees, hedges, or other reflecting objects near; then, if the experiment be fairly tried, a man close under the haystack on one side will scarcely hear a man shouting close under the haystack on the other side. Let A A A—Fig. 3—be the corner of a

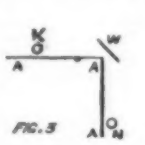


FIG. 3

FIG. 4

house, K an electrical bell ringing steadily, and N a listener. The latter will hear the bell clearly, but let an assistant then hold up a large newspaper or other reflector at W, the sound will be so greatly increased as to give evidence of the astonishing amount previously cut off. No other reflecting object must be near outside the house.

To make sound shadows visible to those present at the lecture, the speaker employed a whistle, A—Fig. 4—of very high pitch, and through which air was steadily passing. He placed opposite it the sensitive flame, K, and the concave metallic reflector, N. The flame was short and fluttering while no obstacle stood between it and the whistle, but every time a hand was placed at W the flame burnt steadily, and lengthened, as represented in the cut.

In his third lecture on "Sound," delivered on Saturday, March 11, Lord Rayleigh said that progressive waves in air can be changed into stationary waves by reflection; at places there is no to-and-fro motion, and these are places of maximum condensation and rarefaction. At the loops there is no change of density, but most motion. To show the formation of stationary waves from progressive waves, Lord Rayleigh took the sensitive flame, W, Fig. 5, fluttering under the influence of the sound of the whistle, which sound came in the direction indicated by the arrow, A, and he placed behind the flame the reflecting board, N, which could be moved backward and forward upon the board, K K. It was thus shown that the board, N, could be placed in certain positions in which it would enable the flame to recover by its length. The flame ceases to flutter at the nodes of the waves, hence when sliding the board, N, to or from the flame, the distance passed by the board between two places of fluttering is half a wave length of the particular sound. By this method the wave lengths of sound can be calculated with considerable accuracy. The flame is most excited at the loops, where we hear the sound least.

FIG. 5

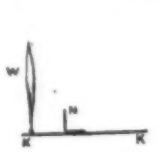


FIG. 6

Lord Rayleigh stated that the sound of the whistle used was so high as to be inaudible to human ears. The principle of construction of the whistle was that of the bird call, like those used by bird catchers. It consisted of a tube, A, Fig. 6, which might be of glass or metal, with a thin metal plate, say of tin or thin brass, at the top, with a hole through its center, and fixed on to A with wax.

Another thin plate with a hole, W, in it was supported a little above the other plate by wax at N N. The air passes through in the direction of the arrow. The round holes in the pieces of metal had sharp edges, and were somewhat truly made. Air was forced through the whistle in the direction indicated by the arrow; its pressure was prevented from changing by means of a manometer, and the whole apparatus was arranged to give a true note—a pure sound of definite wave length; this was done by the aid of the sensitive flame which came from a small pinhole burner. He had also a manometer acting with the flame. A little dust would throw either the flame or the whistle out.

Observations on sound can be made with liquids by means of jets, for instance, if colored water under moderate pressure be allowed to escape as a jet into uncolored water, experiments on sound can be made in that way. The jet "flares" in water by becoming sinuous.

In the matter of the gas jet, the sensitive point is where it issues from the burner; an interval can be made between the jet and the place at which it is lit, and then the jet of unignited gas is a sensitive point. When the gas is ignited near the burner, the flame is sensitive to higher sounds than when the gas is not burning there.

To get a sensitive flame there must be a slight deviation from perfect symmetry in the hole of the burner, and the flame is not equally sensitive in all positions of the burner. When he turned the flame to a right angle to its first position, it was scarcely sensitive to the whistle at all, because not in the position in which it desires to become sinuous, but when a reflector was put so as to cause the sound to impinge upon the flame from a proper direction, it started flaring.

Lord Rayleigh next spoke of the principle of Huyghens' zones as applied to sound. Let the point, A, Fig. 7, be the whistle used in the experiments, and B

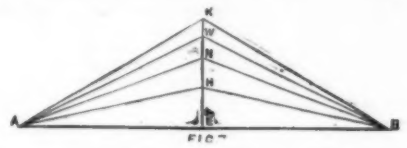


FIG 7

be the sensitive flame, impulses reaching the latter along the line, A E B, may make it flare, while sound reaching it along the line, A H B, may tend to stop the flaring, as it may be half a wave length out in relation to that *via* A E B when it reaches B. Sound reaching B *via* N and K may tend to increase the first effect, and *via* W to reduce it. The zones are thinner as they recede from E in the direction, K. The speaker then arranged the whistle and the sensitive flame so that the latter would not flare at all under the influence of direct sound, but when a circular metallic grating was suspended between the two, the flame flared because the grating cut off the interference waves. The principle of the grating may be explained by Fig. 8. It consists of a large disk of zinc, with annular orifices cut in it, and cross pieces left to hold the whole together; two strings, H and K, suspended it to a horizontal wooden rod; it had to be accurately centered between the whistle and the flame; if drawn slightly to one side of its proper position, it would not act. The grating, said the speaker, might be considered to act the part of a lens concentrating the sound.

FIG. 8

When a suitable bright light is placed in front of a circular opaque disk, a bright spot of light can by proper management be obtained opposite the center of the other side of the disk. Lord Rayleigh showed that an analogous phenomenon can be obtained by means of sound, and that the sensitive flame could be made to flare every time a large glass disk was placed suitably between it and the whistle.

In the course of his fourth lecture on "Sound" at the Royal Institution, Lord Rayleigh returned to the subject of his bird whistle and sensitive flame arrangement, by which the reality of sounds of too high a pitch to be audible were rendered evident. At home he had tried to get the highest pitch possible with this arrangement, and had produced sound waves 0·6 cm. in length and 50,000 vibrations per second. Beyond this wave length of about a quarter of an inch it was not found possible to go, either because the flame would no longer respond or more probably because the whistle ceased to act.

Some of the more shrill sounds can be heard for the first five or six seconds, and then die away. This is a phenomenon of fatigue which comes on after the lapse of the time just mentioned. A rest of the ear for one second enables the sound to be heard again. He once, at Berlin, pointed this out to Professor Helmholtz, who said that from theoretical reasons he had expected it to be the case, but that he had never observed the phenomenon before.

Lord Rayleigh, after dealing with ordinary musical flames, said that there is another way of maintaining vibrations by heat, in which the sound occurs after the removal of a flame, as demonstrated by Rita. In the Royal Institution there was a huge piece of iron pipe—Fig. 9—A B, which pipe was suspended by the ropes,

FIG. 9

K K, to the roof of the theater; at N N a disk of wire gauze divided the tube into a short part below and a long part above. W was a great Bunsen burner and flame, and H H a mirror at an angle of 45°, that the operator might see the flame and the gauze. In the experiment the gauze was made red hot and the flame then removed, upon which a powerful volume of sound came from the tube. The pipe appeared to be about 6 ft. long by 5 in. in diameter.

The sound, said Lord Rayleigh, was of course due to

the vibrating column of air in the pipe; the air vibrated a little backward and forward through the gauze, and at the same time there was a slight upward draught. The conditions were such that at the place of the greatest compression the air took up heat from the gauze. To obtain the sound the gauze must be in the lower half of the tube. A complementary phenomenon is producible by means of hot air and cold gauze; when thus varying the experiment the gauze must be in the upper half of the tube.

Lord Rayleigh, in speaking of progressive waves through the atmosphere, instanced the case of a pipe, in the middle of which is liberated a mass of condensed air; a wave will then go each way; after a time the two waves will separate from each other, and go on unchanged; these waves will no longer tend to subdivide into two, and will not consist of compressed or rarefied air, yet they have a compression, and, at the same time, a motion of progression. To take another case, suppose a sphere of compressed gas to be suddenly freed in the atmosphere, as by an explosion, a wave will propagate itself outward in all directions, and it might be thought that the air would afterward return to its normal density, but that is not so. The wave of progression will be followed by a wave of rarefaction of equal importance, and only after the latter has passed does the air return to its ordinary state. When windows have been broken by such waves, in the majority of cases the windows have been sucked outward. It might be asked why a window should not go first one way and then to an equal extent back again. The window is loosely attached to its frames; the glass is first pushed inward and perhaps gives way, so the wave of compression spends some of its force in tearing away the glass, consequently the wave of rarefaction thereby gains its advantage.

Lord Rayleigh then drew attention to the actual motion of aerial particles during the passage of sound waves, and afterward to the nature of the vibrations of inverted glass bells when excited radially by a violin bow, or circumferentially by a wet finger. Then he dealt with the vibrations of church bells, and what principles are involved in the general shape they have assumed, as the result of a long course of empirical experience. They are particularly rigid about their largest diameter. Next, he dealt with the musical vibrations of metallic plates. Finally, he performed a curious experiment, in which a little paper disk, about as large as a sixpence, was suspended at the mouth of a horizontal resonator by a fiber. During the vibrations the disk did not set itself edgeways to currents of air, but across them.

In the course of his remarks, Lord Rayleigh drew attention to the following table, setting forth the lengths and times of vibration of the waves producing certain musical notes:

Musical Note.	Length in Centimeters.	Number of Vibrations per Second.
C^1	120·0	256
C^2	60·0	512
C^3	30·0	1,024
C^4	15·0	2,048
C^5	7·5	4,096
C^6	3·7	8,912
E^6	3·0	10,000
C^7	1·8	16,000
C^8	0·9	33,000
G^8	0·6	50,000

THE REFLECTING STEREOSCOPE.

THE stereoscope has fared badly of late years at the hands of those who claim to lay down the law in things artistic connected with photography, to whatever school these belonged. It has been somewhat difficult for us to reconcile the arguments of some of those who advocate lack of absolute definition in any plane of a photograph, and the general use of large stops on the grounds that they thereby get a binocular effect (which they do not), while, at the same time, so far as we understand, they condemn the stereoscope without stint, or declared reason either—the stereoscope, which is the only means at present known for getting even an approach to a binocular effect.

We do not by any means intend here to enter into a discussion as to whether stereoscopy can be classed as "art" or not. We say with considerable confidence, however, that stereoscopy with the ordinary lenticoprismatic stereoscope can, at the best, be classed as only very bad art.

What we have to say on this subject is by no means new. It was brought up some six or seven years ago by a German contemporary, but the matter attracted, we think, less attention then than it should have, and no notice has, so far as we have observed, been taken of it since.

The prismatic stereoscope superseded the reflecting stereoscope because of its portability, but it is essentially a defective instrument as compared with the reflecting stereoscope. This is for more than one reason. The first is that the size of the picture being inevitably very small, it is necessary to use powerfully magnifying prisms (really the edges of powerfully magnifying lenses) to get the photographs near enough to see them under anything approaching the angle that they subtended when photographed. This results, in the first place, in a certain strain on the eyes, the result of looking at a very near object through a powerful magnifying glass *not* being the same, even monocularly, as that of looking at the same object at a distance without a magnifier. Then we are looking not only at the photographic image, but at the highly magnified surface of some kind of paper, assuming that prints are used. The combined result of these two things is the appearance certainly as if we were looking at something solid, but as if that solid were a mere model, and often a snow-covered model, of the scene that we are supposed to see.

A defect, perhaps more serious, in the prismatic stereoscope is all that pictures must be seen under very nearly the same angle. This, of course, is fatal to anything approaching a just rendering of the scenes intended to be represented, unless one certain fixed focal length of lens be adhered to in making all photographs for any particular stereoscope.

The reflecting stereoscope is without either of the defects described. If portability be set on one side, there is no limit to the size of the photographs that can be shown by it. There is, of course, some trouble in procuring large stereoscopic photographs. If the subjects be of such a nature that the use of a large camera be allowable, two exposures being made one after the other, the camera being moved 2½ to 3 inches in a direction at right angles to the axis of the lens between the exposures, the best results may be expected. Such a procedure is allowable in all cases where architectural subjects, or others where there is no motion, are to be represented. Means of moving the camera without deflating the axis of the lens will suggest themselves to all readers. When moving objects, or those that for any reason do not allow of the shifting of the camera, have to be photographed, the common stereoscopic camera may be used, and enlargements, say to twelve inches in greatest dimension, may be made. The reflecting stereoscope has been so little seen for many years that there may be readers who do not even know the principle of it. For this reason we illustrate it here. Fig. 1 shows diagrammatically the arrangement in plan.

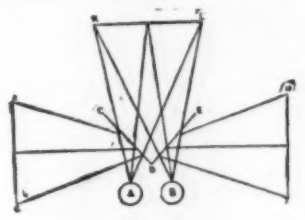


FIG. 1.

Here A B are supposed to be the eyes of the observer. The two photographs are shown at F G, H I. The images of these are reflected by the mirrors, C D, D E. These are arranged so that the angle between them can be slightly varied, and it will readily be understood how it may be adjusted so as to make the two images overlap and form a stereograph at K L.

Fig. 2 shows the reflecting stereoscope in perspective, the letters referring to the same parts as in the diagram.

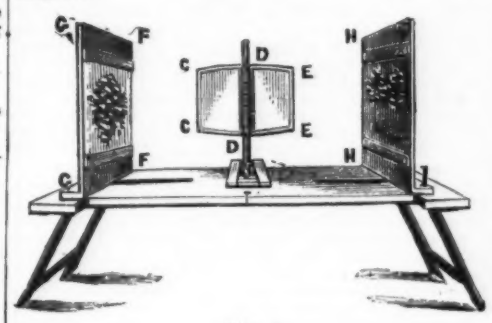


FIG. 2.

The reflecting stereoscope will work just as it is shown, without any lenses or any openings to fix the right position of the eyes when looking into the mirrors. The effect is greatly heightened, however, and the coincidence of the image is facilitated if there be a frame between the mirrors (as they are seen in the perspective sketch) and the user of the stereoscope, there being openings in this frame through which the prints are looked at, these openings being provided with long focus lenses. In this form of stereoscope it is not desirable, as in the prismatic stereoscope, to look through the edges of the lenses. The center should be looked through, and, as in all forms of binocular optical instruments, there should be a means of adjusting the distance between the lenses to suit the different distances there are between the eyes of various people.

As has been said, the lenses to be used with this form of stereoscope are of long focus. In other words, they magnify but slightly, in fact barely perceptibly. By this means we get over the difficulty of looking through a strong magnifier at a surface of paper, and the model-like appearance is at once got over.

It will be seen, by examining Fig. 2, that the distance between the mirror and the photograph can be adjusted at will. The distance between the eye and the prints when the latter are extended to their utmost—that is to say, the distance from the eyes to the mirrors *plus* the distance from the mirrors to the prints—should be made at least equal to the longest focal length of lens used in making the photograph, if these have been made direct; the longest focal length of lens multiplied by the number of times of enlargement, if the common stereoscopic camera have been used and enlarged prints have been made.

By adjusting the distance between the prints and the mirrors, every picture can be seen under its proper angle, so that the second objection to the prismatic stereoscope is overcome.

The focal length of the lenses should, for normal eyesight, be twice the distance between the eyes of the observer and the prints when these are at their greatest distance from the mirrors. The magnifying power of these lenses being only slight, common spectacle glasses will answer quite well, if they are fairly paired as regards focal length. Those who are either short or long sighted should look through the spectacles they commonly use for distant objects.

Those who will take the trouble to make a few fairly large-sized stereoscopic prints on the lines here laid down, and to construct, or have constructed, a reflecting stereoscope, will be astonished at the perfect naturalness of the effect it gives. The writer, a good many years ago, rigged up temporarily such an arrangement, and made a few 12 × 10 photographs for it. Although there was some trouble on account of double reflection, common mirrors of plate glass silvered on the back being used, the results were very remarkable. The mirrors *ought* either to be silvered on the face or to be ground slightly wedge-shaped, so that the images on both surfaces coincide. The trouble in keeping the mirrors bright and untarnished, if the silvering be on the face, and the expense of wedge-shaped mirrors, with surfaces fairly well ground and polished, are among the chief objections to the mirror stereoscope.

Among the many ways suggested for projecting stereoscopic slides by the lantern so that they might be seen stereoscopically, we do not remember to have seen the following, though it seems impossible to us that it has not been thought of before.

Images should be thrown on the two *opposite* sides of a room, either by two lanterns back to back, or by two with the axes parallel, but with mirrors at right angles to each other immediately in front of the objectives, and the images should be brought together by the use of plane reflecting stereoscopes. A fair number of people, each provided with such a stereoscope, could see the images at the same time.—*W. K. B., in Photography.*

CALORIMETRIC DETERMINATION OF COAL.

IN a paper read before the Institution of Civil Engineers on calorimeters for testing fuels, etc., Mr. Bryan Donkin, Jr., and Mr. John Holliday observe, says *The Engineer*, that a buyer of coal should require definite information of the amount of heat he obtains for his money, or, in other words, demand from the coal merchant a guarantee of the calorific value of the coal purchased. But such a determination has not received the attention it deserves, especially in this country; and one consequence of this neglect is that, although there are many methods of determining this value, not one of them is recognized as the standard. The above-named authors quote, from M. Scheurer-Kestner's "Etude sur une Houille Anglaise," figures showing that the number of calories obtained by the different methods varies from 8,452 to 9,268; and, in a recent communication to the Iron and Steel Institute, M. Scheurer-Kestner asserts that differences of as much as +6 and −6, that is to say, a divergence of 12, have already been found to exist between the calorific value of a fuel as calculated by Dulong's law and that obtained by direct testing.

To throw as much light as possible on this contested question, the French Societe d'Encouragement pour l'Industrie Nationale—a body resembling the English Society of Arts—put a sum of money at the disposal of its chemical arts committee for studying the calorific value of the principal fuels used in industry. M. P. Mahler, Ingenieur Civil des Mines, undertook the task, and, at the laboratory of the Paris School of Mines, carried out a very extended series of experiments, the results of which have been given to the world in the *Bulletin* of the above-named society, forming the most complete and comprehensive treatise on the subject that has yet been published. Moreover, all the details of the tests and analyses are given, a circumstance which not only affords the best guarantee of scrupulous care and scientific good faith, but also enables other experimenters in the same field to check the results and extend the experiments.

M. A. Carnot and M. H. Le Chatelier, delegated by the chemical arts committee of the Societe d'Encouragement to report on M. Mahler's labors, observe that, not content with studying coal and the liquid or gaseous fluids derived from it, he has extended his investigations into various other fuels, and has added some important observations on the spontaneous oxidation of coals, while he has also modified, so as to bring it within the reach of manufacturers, the calorimetric bomb of M. Berthelot and M. Vieille, with the approval of the first named. That this apparatus is appreciated is proved by its having been rapidly adopted by several steam users' associations and railway companies, while a specimen has also been supplied to the Science and Art Department, South Kensington.

The Mahler shell is practically a strong chamber, in which a sample of fuel to be tested is placed, when it is closed hermetically, after which oxygen is introduced under pressure. The shell is then immersed in the water of a calorimeter and the fuel ignited, when it burns completely and almost instantaneously, the water formed by the combustion of the hydrogen becoming condensed on the inside surface. The heat given out is then transmitted, without any loss whatever, to the water of the calorimeter, and is easily estimated, as in all calorimetrical operations. On account, however, of the rapidity of the operation, most of the corrections which are usually necessary, such as those arising from the evaporation of the water and variations of the surrounding temperature, are not required. The pressure of the oxygen is determined by the condition that combustion be always complete, so that an excess of oxygen is indispensable.

Of the accompanying engravings, Fig. 2 shows a vertical section of the Mahler shell, forged out of high-class mild steel, possessing a tensile strength of 50 kilog. per square mm. (31 tons per square inch), with 22 per cent. of elongation. It weighs about 4 kilog. = 8¼ lb., and has a capacity of 654 cubic centimeters = 40 cubic inches, the walls being 8 mm. = ⅓ in. thick. It is closed by a cover with annular fillet joint and lead ring. The cover is fitted with a ferro-nickel cock, R, with conical screw and stuffing box, E, for the introduction of oxygen under pressure; and the platinum pan, with its suspender, for holding the fuel to be tested is clearly shown. The fuel is ignited by a small spiral of iron wire, through which an electric current is passed at the desired moment. The shell is nickelized outside and enameled inside for resisting the corrosive and oxidizing action of combustion; but the coating of enamel is so thin that it does not interfere with the transmission of heat.

Fig. 1 shows the arrangement of the shell in the calorimeter, with accessories, as installed at the Paris School of Mines. A is the insulated casing of the calorimeter, D; B the Mahler shell; G the bracket for supporting the spindle, K, of the helicoidal agitator, S, which is worked by the lever, L, with a movement like that of hand drills; I is the iron wire igniter and M the pressure gauge; O, the reservoir of oxygen under pressure and P the battery for ignition. The calori-

meter, made of sheet brass, has considerable capacity, on account of the large size of the shell. It contains 2·2 kilog.=5 lb. of water, which is a sufficiently large quantity to render negligible any errors arising from the loss of a few drops of water or from evaporation, all of which circumstances, while being favorable from a scientific point of view, permit a manufacturer to carry out his own calorimetric tests.

The calorific power of a solid or liquid fuel is determined in the following manner: A gramme (= $\frac{1}{28}$ oz.) of the substance to be tested is placed in the pan or capsule; the iron wire igniter is made ready, the cover of the shell is screwed down tight, the screw cock is put in communication with the oxygen reservoir, oxygen being allowed to enter the shell until the gauge shows that a sufficient pressure has been reached, generally from 20 to 25 atmospheres.

After having closed the cock of the oxygen tube and the screw cock of the shell, the nut of the copper tube, which places the shell in communication with the oxygen reservoir, is unscrewed. Great care must be exercised in introducing the oxygen, so as not to disturb the test sample in the capsule. The shell, thus prepared, is placed in the calorimeter, and the agitator and thermometer are adjusted. A known quantity of water is poured into the calorimeter, and is agitated for a few minutes, so as to equalize the temperature of the whole apparatus, when the observation begins. The experimenter notes the temperature every minute for five or six minutes, and then fires the charge by means of the battery. The combustion is almost instantaneous; but the transmission of heat to the water of the calorimeter requires a few minutes. The temperature is recorded half a minute after the ignition, and then at the end of one minute, after which the temperature is taken every minute until the thermometer begins to descend, and then for about five minutes more, to determine the *regime* of the thermometer, during all which time the agitator must be worked regularly. The principal data for the calculation are now taken, and especially one correction is made, viz., the loss of heat in the calorimeter before the thermometer reaches its maximum; and this is very slight, on account of the rapidity of the operation and the large quantity of water contained in the calorimeter.

At the close of the observation the screw cock is first opened, after which the cover is removed. The inside of the shell is washed with a little distilled water for collecting the acid liquid formed during the combustion, any acid drawn along by the oxygen when the cock is opened being negligible. The weight of nitric acid formed is determined by means of a solution of potash of known strength; and it is advisable, when testing substances poor in hydrogen, like coke, and therefore incapable of furnishing, by combustion, sufficient water to form nitric acid—it is advisable in such a case to pour a little water into the shell, as otherwise only hyponitric acid will be obtained.

If Δ = the difference of temperature observed, and α the correction for cooling; P, the weight of water in the calorimeter; P', the equivalent in water of the shell and its accessories; p, the weight of nitric acid determined, and p^1 the weight of the iron wire spiral; 0·23 cal. being the heat of formation of one gramme of diluted nitric acid and 1·6 cal. the heat of combustion of a gramme of iron, then:

$$Q^o = (\Delta + \alpha)(P + P^1) - (0{\cdot}23\ p + 1{\cdot}6\ p^1)$$

When testing coal in this manner, no account need be taken of the small quantity of sulphuric acid resulting from the oxidation of the sulphur, and which is determined as nitric acid, the error being negligible in an industrial, that is to say, commercial test. While oil, tar, and heavy mineral oils may be tested in the manner above described, liquids which give out vapor, such as raw and rectified petroleum, must be contained in a glass flask, into which the igniter is passed, care being taken, after the shell is closed, to permit as large access of oxygen as possible to the liquid. In determining the calorific power of a gas of constant volume, a vacuum is produced in the shell, the exact capacity of which is known; and it is filled with the gas. A vacuum of a few millimeters of mercury is then produced, and the shell is filled, for the second time, with gas at atmospheric pressure and the surrounding temperature, when the operation is continued as for solids and liquids; but care must be taken not to dilute the gas with so large a quantity of oxygen as that the mixture shall cease to be combustible.

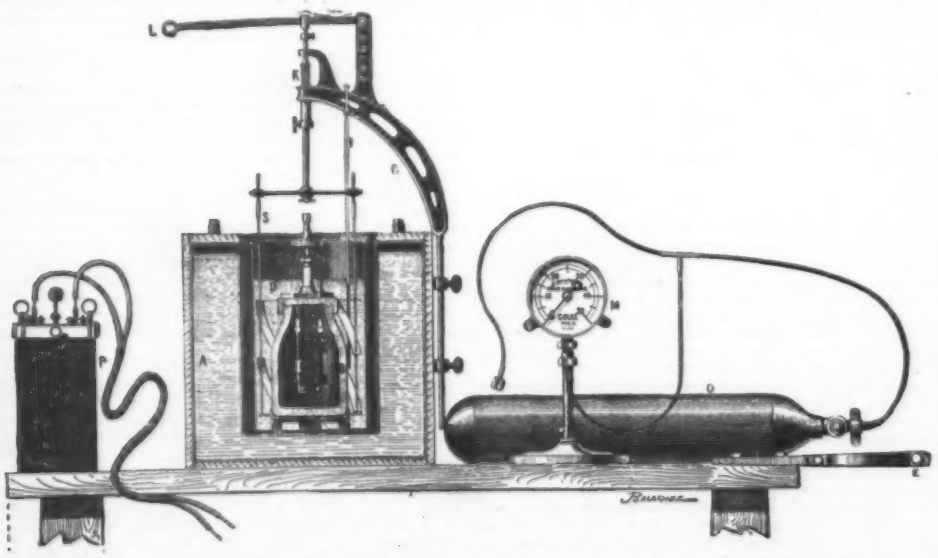


FIG. 1.—APPARATUS FOR CALORIMETRIC DETERMINATION OF FUEL.

A dry sample of Nixon's navigation coal, which gave by analysis the following results—fixed carbon without ash, 86·3; volatile matter without water, 10·15; hygrometric water, 1·85; and ash by calcination, 1·7—showed on being tested in the shell—and the whole test only took 35 minutes—a difference of temperature corrected to 3·18 deg. C. = 5·7 deg. F. The heat given out is therefore 3·18 gr. × 2681 = 8·5256 cal. The heat of combustion of the iron wire is 0·025 × 1·6 = 0·04 cal. The heat of formation of nitric acid is 0·15 gr. × 0·23 = 0·0345 cal. Total 0·0745 cal. Deducting this from the total quantity of heat observed gives the calorific power sought, viz., 8·451 cal.; or for a kilogramme of coal 8,451 cal. = 15,211 B. T. U. per lb., with condensation of the water formed.

A analysis of Wilson's Dross Douglas Park Colliery coal, made for Mr. Bryan Donkin, Jr., by Mr. R. R. Tatlock, city analyst of Glasgow, showed: Carbon, 54·48 per cent.; hydrogen, 4·49 per cent.; oxygen, 8·87 per cent.; nitrogen, 1·61 per cent.; sulphur, 2·17 per cent.; ash, 16·54 per cent.; and water, 7·84 per cent.;

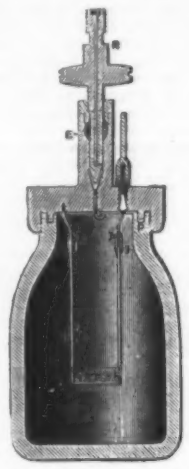


FIG. 2.—MAHLER SHELL.

while the calorific value obtained by M. Mahler was 6,020 calories per kilogramme = 10,840 B. T. U. per pound, and that by M. L. A. Legros, in the modified Thomson calorimeter, was 10,830 B. T. U. per pound. This apparent concordance between the figures obtained by M. Mahler and M. Legros is only accidental, because the sample of Dross Douglas Park coal tested by M. Mahler contained 18·8 per cent. of ash, while that tested by M. Legros contained 16·54 per cent. If this difference be taken into consideration, the calorific powers obtained by the two experimenters cease to be concordant, as, indeed, was pointed out by Mr. Thwaite in his answer to M. Legros at the last meeting of the Iron and Steel Institute.

M. Mahler began his labors by making an elementary analysis of seven descriptions of coal, all French, excepting one of Pennsylvania anthracite and an anthracitous coal from Tonkin. He calculated the calorific power of these coals by Dulong's formula as modified by himself, and then compared the results with those obtained by direct test in the shell, putting them side by side in a table, which shows that contents of nitrogen, the mean of which is one per cent., have no relation with the calorific power. He then compiled a table with the results of analyses and tests of forty-four fuels, including thirty-one of coals, six of lignite, peat and wood, and seven of natural fuels, modified either by the action of high temperature or by that of the air. The coals which were the object of his investigations naturally occupy the largest place, most of the French districts being represented, but Wigan and Niddrie cannel being also included. All the results were calculated with abstraction of the ash and water; and under these conditions the various fuels were compared with one another, and their composition with the calorific power.

It appears from the tables that, with abstraction of the ash and the hygrometric water, the calorific power of solid fuels of vegetable origin varies, in round numbers, from 4,500 calories for wood to 8,900 calories for bituminous coal per kilogramme, which is equal to from 8,100 to 16,020 English heat units per pound. The least calorific are the dry flaming coals, whose heat of combustion varies from 7,840 to 8,570 calories per kilogramme, or 14,114 to 15,466 English heat units per pound, after which come the gas coals, 8,400 to 8,770 calories per kilogramme, or 15,120 to 15,786 English heat units per pound. The most economical coals would appear to be the bituminous and semi-bituminous coals, showing from 8,570 to 8,870 calories per kilogramme, or 15,466 to 15,956 English heat units per pound. It was found that certain anthracitous coals have a high calorific power, while the true anthracites resemble, so far as their heat of combustion is concerned, the ordinary flaming coals giving 8,100 to 8,700 calories per kilogramme, or 14,568 to 15,660 English heat units per pound. Higher than the above calorific powers are those of colza oil, 9,600 calories per kilogramme, or 17,280 English heat units per pound, and petroleum and lighting gas, about 11,000 calories per kilogramme, or 19,800 English heat units per pound.

The two English coals mentioned above, viz., Wigan and Niddrie cannels, gave the following respective results: Carbon, 78·38 and 76·54 per cent.; hydrogen, 5 and 6; oxygen and nitrogen, 5 and 8·8; hygrometric water, 0·6 and 3·95; ash, 10·9 and 4·7—or, with abstraction of the ash and water, C, 88·56 and 88·79; H, 5·7 and 6·5; O and N, 5·7 and 9·6—volatile matter with abstraction of the ash and water, 31·6 and 53 per cent.; calorific power observed, 7,761 and 7,703 calories per kilogramme, or 13,970 and 13,865·4 B. T. U. per pound; ditto, with abstraction of the ash and water, 8,768 and 8,431 calories per kilogramme, or 15,804 and 15,176 B. T. U. per pound.

The above data permit of considering the controverted question as to whether there is a relation, sufficiently near for practical use, between the elementary composition of fuels and their calorific power, which is a function more or less complex of the composition. This may be put in a simple form by stating that the heat of combustion of a fuel is equal to the difference between the heat of combustion of its elements and the heat that was disengaged in its formation. If Q^o be the calorific power of the fuel, Q the heat of combustion of its elements, and W the heat of combination: then $Q^o = Q^1 - W$, or $W = Q^1 - Q^o$. Let H equal the percentage of hydrogen in the combustible, η the heat of combustion of the hydrogen, C the content of carbon, γ the heat of combustion of carbon, and O, N the percentages of oxygen and nitrogen. As W is evidently a function of the oxygen and nitrogen, W = ω (O + N). From the above the following formula may be compiled:

$$Q^o = C\gamma + H\eta - \omega(O + N)$$

Adopting for the value of η, 34,500 calories per kilog., which is the heat of combustion of hydrogen with condensation of the water formed, and taking γ as the heat of combustion of charcoal, viz., 8,140 calories per kilog.—which is nearer the truth than the 8,080 calories generally taken—the expression of the calorific power of one kilogramme of a fuel may be stated as follows:

$$Q^o = \frac{8{,}140\ C + 34{,}500\ H}{100} - \omega(O + N)$$

Now, it may be ascertained by experiment that it is possible to assign to ω a constant numerical value, as the expression W = 30 cal. (O + N) practically represents the calorific power of a fuel defined by the contents of C, H and (O + N).

The formula obtained by M. Mahler under these conditions is, for a kilogramme of fuel,

$$q = \frac{8{,}140\ C + 34{,}500\ H - 3{,}000\ (O + N)}{100}$$

in calories. It would appear to give the calorific power of a given fuel of vegetable origin, such as wood, coal, lignite, and peat, with sufficient exactitude for all practical purposes. The above formula may also be stated as follows:

$$q = 111{\cdot}4\ C + 375\ H - 3{,}000$$

which is more easily calculated.

As regards Dulong's law, M. Mahler's experiments show that it gives the calorific power of coals with sufficiently near approximation for industrial purposes, but that it cannot be applied to fuels like wood and peat, which contain a high percentage of oxygen. M. Mahler also remarks that his formulæ and that of Dulong do not give correct results when applied to coals of the cannel class.

The calorific value given by the new apparatus is the theoretical heat of combustion of the substance tested, with condensation of the water formed by combustion of the hydrogen. The hygroscopic water of the fuel is moreover in the same state before and after combustion, that is to say, condensed. Under certain circumstances it may be asked what becomes of this figure, if it be supposed that part of the theoretical heat is expended in vaporizing the hygroscopic water and the water formed, as happens on the bars of furnaces. If Q be the heat of combustion of one kilogramme of fuel; P, the calorific power, supposing the water vaporized; A, the content of hygroscopic water; and H, the content of hydrogen corresponding with 9 H of water formed; then, adopting 600 calories for the vaporization heat of the water,

$$P = Q - \frac{A + 9\,H}{100}\,600$$

Now, the term for correction $\frac{A + 9\,H}{100}\,600$ is easy to determine with sufficiently near approximation for practical purposes. Simple desiccation gives the quantity, A; and it may be remarked, concerning the product of 9 H, that fuels may be divided into several classes, in which the contents of hydrogen vary so little that variations in the term of correction $\frac{9\,H}{100}\,600$ may be left out of the question. It may be asserted from the results of a large number of analyses that with abstraction of the ash and hygroscopic water, the mean content in hydrogen of gas and flaming coals is 5·5 per cent., corre-

sponding, in round numbers, with 300 cal. for the value of $\frac{9\,H}{100}$ 600; the mean content in hydrogen of bituminous coal is 5 per cent., corresponding with 270 cal.; that of semi-bituminous coals is 4 per cent., corresponding with 220 cal.; that of poor and anthracitic coals is 3 per cent., corresponding with 160 cal.; and that of anthracites differs but little from 2 per cent., giving 110 cal.

The values given above—which must necessarily be modified by calculation, for a coal containing a given proportion of ash and hygroscopic water—of $\frac{9\,H}{100}$ 600, considered as constant in each class of coals, permit of calculating the calorific power, with vaporization of the water, with a sufficient degree of correctness. It may be considered that the figures thus obtained will generally differ by less than 1 per cent. from that which would have been given by calculation while taking exact account of the content in hydrogen, obtained by elementary analysis, which M. Mahler deems perfectly useless. To take an unfavorable example, in which the actual content of hydrogen differs appreciably from the mean, given above, the calorific value of semi-bituminous coal from the Grand Combe Colliery was found by the shell to be 8,750 cal., with abstraction of the ash and water. As the content of hydrogen is 4·46 per cent., the calorific power, taking into account the vaporization of the water formed, is

$$8{,}750 - \frac{4{\cdot}46 \times 9}{100}\,600 \text{ or } 8{,}510 \text{ cal.}$$

By the approximate method the figure obtained is 8,750 — 220 = 8,530 cal., that is to say, a difference of only 20 cal. per kilogramme, or 36 B. T. U. per lb.

COLORS FROM IRON ORES.

By WALTER J. MAY.

USUALLY poor ores hold more or less color, and where the tint or color of this substance is bright enough its value is considerable. Bright red is generally highest in value, and occurs less often than others, therefore in working mines where color occurs, it is advisable to adopt some form of classification to secure the best return. At the same time, it is well to carefully calculate what effect classification will have on the sale of the whole of the material produced. If an unclassified material sells freely at a moderate price, and when classified only part sells at an enhanced price, and the rest hangs about on hand, then the question will arise as to whether the part sold will produce as much as the total would in its crude state. If it does, there will be little chance of loss, but if it does not, then it becomes a matter of grave consideration as to whether it is not the better plan to sell the crude material as it is extracted.

The color may exist as layers in the deposits; in churns or pot holes, where it will sometimes be found mixed with other matters; or it may be distributed through the body of the ore itself. In this latter case it can only be extracted by washing, and this process necessitates the use of large settling tanks, and also involves a great amount of labor, as the color must be practically dry to be salable. Unless the color is good, it is therefore not the most probable speculation for prospective profit. Another aspect of the question occurs where it is necessary to concentrate ores, and the color beomes recoverable as a by-product, in which case a decent profit is practically certain, as the additional labor could scarcely amount to the value of the color recovered, as at least it should fetch from £1 to £5 per ton, according to its color and content in ferric oxides. Of course this refers to the material in an unground state, and requiring grinding to take off the roughness caused by grains of sand or other hard matter which would almost certainly be present.

Taking the whole question of natural colors, it may be worth while to point out that they are almost invariably of a somewhat low metallic value, and the hard ore with which they occur is consequently benefited by their removal, its metallic content being made much higher thereby. In some poor ore the writer has been dressing lately, which in its crude state gives only 45 per cent. metallic value, 57½ per cent. of ore having a metallic content of 58·25 per cent. and 13 per cent. of color, worth 30s. per ton, is produced, the waste being 29½ per cent. The furnace ore thus has an increased value of 4s. 1d. per ton, and by the removal of insolubles, so that they only remain as 6·75 per cent., the hard ore becomes very readily salable. Based on the present selling price of the crude ore, it is increased 3s. per ton by an expenditure of 1s. per ton, and with an increase in selling price the value per ton based on the total output is still further enhanced. It would most obviously be unfair to go into details, but on an output of 30,000 tons of crude ore, by concentrating, and by separating the color, an additional profit of £2,800 would be made over the present profit, a sum equal to a 5 per cent. dividend on £56,000.

In some cases drying and grinding only is necessary in preparing these natural colors for use, while in others it is desirable to separate certain parts of the hard granular matter to secure the best color, and this would be a simple process. On the other hand, a more elaborate wet process could be adopted with some ores very profitably, as, by separating them carefully, not only will the color be heightened, but obnoxious elements could be removed, and if necessary two or more grades of the color material produced, and some of this at least would not have to be ground, as it would readily reduce in the paint mill, being in an extremely divided state when separated from the other materials with which it is mixed. Some classes of color will sell almost without limit to the quantity offered, while others will hang on one's hands, and this renders it a necessity that trial separations should be made by some one who is practically acquainted with the work. Not only has color stuff alone to be considered, but the question of turning the by-products to account has also to be considered, and this involves a practical knowledge of separating the other constituents of the crude material.

A curious example of the necessity of knowing how to separate practically came to the writer's notice lately, and arose in this way: A sample of ore was sent from abroad by a friend to a chemist, who, by the way, is not up in metallurgical analysis, and he was requested to state the metallic contents. Well, iron, tin and arsenic were present, and the chemist asked the writer how to practically separate these. The only way occurring to the writer was to crush fine, take out the iron with a magnetic separator, and then to roast out the arsenic—and also sulphur, if any—recovering the fumes in the ordinary way, or, what would be preferable, to take out the iron and send the tin and arsenic combined to be treated in England.

A vast amount of fine color material goes to the blast furnaces, owing to want of knowledge of its value, and if carefully separated this would add greatly to the value of the working of the mines from which it is raised. In fact, while the iron trade is so much depressed both mine and furnace owners should examine their ores and see if some additional income could not be derived from the presence of color stuffs, and they could easily have a sample dressed out to this end and at very little expense or trouble to themselves.

PHOTOGRAVURE BY THE TALBOT-KLIC PROCESS.

MR. HERBERT DENISON, of Leeds, in a recent lecture on the Talbot-Klic photogravure process, before the Photographic Society of London, said that the carbon transparency is made on a piece of brown tissue, ½ in. larger than the transparency mark opening. The copper plate must be quite free from scratches and blemishes; any imperfect plates should be returned to the makers; those used must be perfect in polish and preferably with beveled edges, as it avoids the risk of scratching which obtains if the plate is beveled afterward.

To clean the plate, put it on a piece of paper larger than itself, and rub the upper surface of the plate with a plug of cotton wool moistened with "American" potash, not strong enough to cause tarnish. When all signs of greasiness have disappeared, rinse it under a tap, then rub it with another plug of cotton wool, moistened with weak nitric acid, strength one to three. Rinse again, then go over the plate with washed whiting, moistened with a 5 per cent. solution of ammonia. The whiting can be washed like emery, by the water-suspension method. The plate is lastly rinsed with hot water and wiped with a perfectly clean cloth, from which all grease and soap have been extracted.

The dusting box is 12 in. square at the base, and 18 in. in height; this is large enough for any plate up to 10 in. square. This dusting box is represented at A, Fig. 1. Through the bottom of the box, B B, wire nails

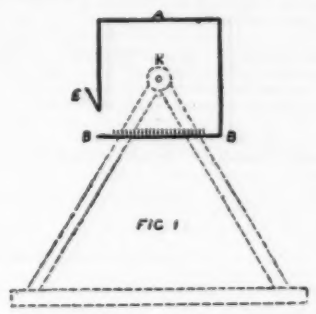


FIG 1

are driven from the outside, and project 1 in. inside; the nails are 1 in. apart and cover a space 6 in. square; their points form a support on which the copper plate can rest horizontally, and face upward. Inside, the box is lined with glazed paper, so that no dust may temporarily adhere to it, and afterward fall in patches. At E is a door hinged so as to open upward, as represented in the cut; it is the full width of the box, and permits the insertion and removal of the plate. The box can be made to revolve on two pivots, one of which is represented below K. The dotted lines represent the stand supporting the two pivots and the box.

About ½ lb. of powdered bitumen is put in the box, which is next revolved about twenty times, and then brought to rest with the door at the bottom, and steadied by a little peg. The plate is then laid on the nails, face upward, and the door closed from three to ten minutes, when the dusted plate is taken out. The more delicate the subject the finer must be the grain; a dark subject requires a large quantity of dust, somewhat coarse in character. The quality of the grain can be varied by allowing a little longer or shorter time before the insertion of the plate, or by leaving the plate in the box for a longer or shorter time, or by inserting the plate a second time, after again revolving the box. In the first case the dust may be allowed to settle for about two minutes, and the plate then inserted; the operation may be repeated should the deposit be insufficient. In a photograph with an ordinary amount of light and shade, the dust may settle from ½ to 1 minute, and then the plate left in for 10 minutes, receiving thus a mixture of coarse and fine dust.

In his early experiments he was troubled by dust settling on the plate in harmonic figures: this can be avoided by keeping the dust and the box in a perfectly dry state. When unevenness still appears, it is generally at the edges of the plate, and may be avoided by putting that plate on another one larger than itself. The character of the grain may be ascertained by examining it with a magnifying glass.

The plate has next to be placed upon a slab of iron larger than itself and about ¼ in. thick, to distribute the heat of the ring gas burner placed beneath. A sheet of paper is first put on the iron slab, and when the latter is hot enough the copper plate is put on the paper, by the ends of which it can be lifted. When the "ground" first becomes transparent, then grows darker and shows the appearance of bloom, the plate is removed and allowed to cool spontaneously. When the plate has not been heated enough, it will not resist the etching fluid sufficiently. If heated too much, or kept hot too long, the particles of bitumen will run together and not give the proper grain. When the plate is cold a camel's hair brush should be applied to one corner to see if any dust is removed. Several plates can conveniently be done at once and stored in a grooved box.

The plate is next placed face upward, under water, in a developing dish, and the exposed tissue applied under water in the usual way, the squeegee is applied, and the plate afterward allowed to rest for ten minutes face upward upon a sheet of blotting paper, to give the film time enough to attach itself. Development is then effected as usual in the carbon process. The plate is dried by applying a 50 per cent. solution of methylated spirit, and afterward stronger and stronger spirit. The margin and back of the plate are then protected by black varnish, but care must be taken not to injure the gelatine film, which is still very tender. The film is also hygroscopic, and should not be left in a warm room, or it may crack off the plate. Treating it with glycerine to avert this introduces other difficulties. No retouching can be done on the plate beyond stopping pinholes with black varnish.

The five etching solutions of perchloride of iron are of 45°, 40°, 38°, 35°, and 27° of Baume's scale in strength. The stronger they are the less do they attack the plate, and the strongest has to be used first. Experience is necessary to tell how long a plate should be left in one dish before it is transferred to the next. The darkening should be allowed to go on until it ceases to spread to the more thickly coated parts of the image, and then the plate should be put in the next solution. The danger is that the bitumen grain may be undermined. Possibly the plate may be left in the solutions for the following times: One, 1 minute; two, 2 or 3 minutes; three, about 3 minutes; four, 2 or 3 minutes; five, until the highest lights begin to be discolored by the etching fluid, and from ½ minute to 1 minute longer. It is impossible to state the proper times exactly; much depends upon the hygroscopic state of the atmosphere. The etching solutions should all be of the same temperature, say 70° F.

The Autotype Company, he said, makes a special transparent red tissue for this process, so that the progress of the etching may be watched, or the standard brown tissue can be employed. After the last etching the film is rubbed off the plate with the fingers, the black varnish removed with benzole; the plate is next washed with turpentine, and finally rubbed with whiting and ammonia. The whiting is allowed to dry on the plate and rubbed off afterward. Portions of the lights which have been etched too deeply can be reduced by a steel burnisher, and some defects removed with an etching needle. A roulette will strengthen too light portions of the print; it is a little wheel with a serrated edge.

From twenty to twenty-five impressions can be taken from the plate. Should more be wanted, it should first be "steel-faced," that is to say, a slight coating of iron is thrown down upon it by electricity, from a solution of ammonia chloride of iron. This facing process is worked at the Polytechnic. When one facing is worn out another can be applied. The unfaced copper plate is so tender because it consists largely of minute vertical copper cylinders, which soon give way under pressure unless faced with iron. Thus let the upper part of Fig. 2 represent an etched plate with no grain, Fig.

FIG 2

FIG. 3

3 represents its surface with the grain produced by the little copper pillars, which hold the ink, so that it is not readily wiped out.

PREPARATION OF URANIUM.

By HENRI MOISSAN.

OF late years metallurgy has utilized powerful currents for producing electrolyses. The new preparations of magnesium and aluminum are instances, but we consider that the heat produced by the electric arc may also be especially utilized when it is required to reduce with carbon certain oxides hitherto regarded as not capable of reduction.

Thus the use of the electric furnace enables us quickly to prepare the refractory metals, which hitherto could be obtained only with difficulty, or not at all.

It is merely needful to place in the cavity of a furnace of lime a certain quantity of magnesium, which is absolutely stable at the highest temperatures of the arc, and to arrange above it a crucible of retort coke containing the mixture of carbon and oxide to be reduced.

If the metal is volatile, we cause the furnace to be traversed by a current of hydrogen and the metallic vapors are condensed in a refrigerated receiver. In this manner we prepare calcium, barium, and strontium. If the metal is not appreciably volatile, it remains at the bottom of the crucible in the form of an ingot This is the case with uranium, the preparation of which we are about to describe.

Metallic uranium had been obtained by Peligot in very small quantities and with great difficulty by reducing uranium oxide with an alkaline metal. At ordinary temperatures the uranium oxides are not reducible by carbon. It is not the same, as I have already intimated, at the high temperatures which we can apply in the electric furnace.

To obtain this metal we ignite, in a porcelain capsule, uranium nitrate, which may be prepared in a state of great purity. There remains a reddish mixture of uranium sesquioxide and of the green oxide U_3O_4. We add to this mixture a slight excess of charcoal in powder, and the whole is strongly compressed into a coke crucible. On submitting this mixture, in the electric furnace, to the action of the arc produced by a current of 450 amperes and 60 volts the reduction is completed in a few moments. After cooling, we extract from the crucible a metallic ingot of a brilliant fracture and of great hardness, which, if thrown upon porcelain, or if its fragments are agitated in a glass bottle, gives brilliant sparks from the combustion of traces of the substances. There occurs—though with far greater luster—a phenomenon analogous to the combustion of particles of iron which take fire by simple friction in the air.

The yield of uranium by this process conducted in

the electric furnace is very great. An experiment lasting twelve minutes yielded a regulus of from 200 to 220 grammes. The 600 grammes which I have the honor of presenting to the academy have been prepared in these operations, each reduction requiring only about ten minutes.

This sample does not consist of pure uranium.* It is a true cast metal, and its proportion of carbon varies with the predominance, whether of the oxide or of the coke in the mixture.

A qualitative examination showed that merely uranium and carbon were present.

Determinations of different specimens of this uranium carbide gave the following results:

	I.	II.	III.	IV.
U..... ..	86·25	89·46	89·10	95·70
C.....	13·50	11·08	10·24	5·02

We add that these uranium carbides slowly decompose water at the ordinary temperature—a property to which we shall have occasion to revert—and that their melting point is much higher than that of platinum.

In fine, we have obtained a true cast uranium at a high temperature by the direct reduction of the oxides of uranium by coke. In a future research we shall give the characteristic properties of this compound, and indicate how it may be refined and what are the properties of the pure metal.—*Comptes Rendus*, cxvi., No. 8.

THE PERMANENCY OF EGYPTIAN AND OTHER PIGMENTS.

MR. W. J. RUSSELL, F.R.S., in the course of a lecture at the Royal Institution on Egyptian pigments, under the chairmanship of Dr. William Huggins, said that it is useful in these days to know what pigments have resisted the action of air and light from 4,000 to 6,000 years. He had been analyzing some pigments brought from Egypt by Mr. Flinders Petrie, who had also supplied the dates at which they had been used. One of the pigments much used on the outsides as well as the insides of the ancient Egyptian temples was a red, which he—the speaker—had found to consist of 70 to 80 per cent. of ferric oxide; the remainder was practically clay; it was, in short, an oolitic hematite. He had found that he could not rub this hematite down dry, but by rubbing it under water in a great heavy Wedgwood mortar, it could be brought into powder, and was then immediately ready for use without the admixture of any vehicle, for it would stick to the fingers, face, clothes, hair, or anything else, in an unpleasant manner. He put some of it in nitric acid to show that that liquid had no effect upon it; he made red hot part of a thin plate of iron painted with it; it grew darker under intense heat, but when the plate cooled, the paint resumed exactly its original color. This red, said the lecturer, is permanent and unfadable in every way.

Dr. Russell then drew attention to a yellow ocher, unfadable, and consisting of peroxide of iron combined with alumina, lime, and some water—in short, a colored clay. This yellow is changed permanently by heat into a kind of a burnt sienna color. He next exhibited an orange color, made by Nefermat about 4000 B. C. The said Nefermat was one of the first pyramid builders; he also erected temples. The figures in his colored work were cut into the stone; they were likewise undercut and sized, after which the hollows were filled in with the colors in a pasty state. He mixed his colors with gum, and in one of his inscriptions he said that "he made it for his gods in unspoilable writing."

The earliest blue color used by the ancient Egyptians was chessylite. In later times they found out how to manufacture a blue which he, Dr. Russell, had also managed with much difficulty to make; it was a "frit," not much differing in constitution from plate glass, as shown by the following table:

Constituents.	Egyptian Blue Frit.	English Plate Glass.
Silica.....	88·65	76 30
Soda	0·81	16·55
Copper oxide	2·09	.....
Lime	7·88	6·50
Iron oxide, Alumina, etc., ...	0·57	0 65
Total.....	100 00	100·00

The white pigment the ancient Egyptians used was a sulphate of lime, which had a greasy texture, and was insoluble. They also used a pale pink color, which consisted of 99 per cent. of the sulphate of lime just mentioned, mixed with an organic substance, which he had discovered to consist of alizarine and madder purple. He exhibited upon the screen the absorption spectrum of a weak solution of the ancient organic substance, and the bands of purpurine appeared.

A word of criticism may here be added. Sulphate of lime is sensibly soluble in water to the extent, roughly speaking, of about one grain to the ounce, hence the white pigment mentioned used in the dry atmosphere of Egypt, and inside the temples, may prove less durable in our own climate outside buildings. This remark is made as a caution to those who might think of using sulphate of lime in England as a pigment to be exposed to the weather, outside buildings, or other structures, because it has stood so well in Egypt.

CRYSTALLIZATION OF COPPER SULPHATE.—The liability of crystallized copper sulphate to effloresce has recently been investigated by Messrs. Baubigny and Pechard, who find that crystals obtained from neutral solutions are much less liable to efflorescence than those obtained from acid solutions. Even very small traces of sulphuric acid affect the development of this phenomenon. They have found that crystals prepared from very slightly acid solutions were quite white before those prepared from a perfectly neutral solution hardly showed any signs of efflorescing. If, however, care is taken to insure the solution from which the crystals are to be obtained being absolutely neutral to methyl orange, a definite and thoroughly stable compound will be obtained.

* A rather large number of metals have never been obtained in a state of perfect purity; some contain carbon, silicon, or the alkaline metals. We know now that a very small quantity of these impurities may modify the physical and even the chemical properties of these elementary bodies. To us it seems important to determine with care the state of purity of the metals obtained by means of the electric furnace.

ESTIMATION OF MECHANICAL WOOD IN PAPERS.

GODEFFROY AND COULON'S METHOD.

A METHOD for accurately estimating the amount of mechanical wood in paper has been the subject of much investigation of late, some of the methods which have been suggested and investigated being of unusual interest. In Germany, where paper testing is more universally demanded than in England, chemists have made extensive experiments on this subject.

Dr. Muller was the first to suggest a quantitative analytical method for estimating mechanical wood. It was based on the solubility of pure cellulose in cuprammonium, but it was soon found to yield anything but accurate results, and has been abandoned as inapplicable.

Messrs. Godeffroy and Coulon, in 1888, introduced a method based on the reducing power of ligneous wood on chloride of gold in solution. These investigators made and published a series of researches setting forth the details of the manipulation of their method and their results. They found that linen and cotton cellulose did not act upon the chloride of gold, nor did cellulose prepared from straw or wood, provided these are previously digested in water, alcohol and ether in succession. Wood, on the contrary, did not lose its reducing power after treatment with these reagents. A method was therefore formulated on these observations, of which the following is the outline.

A quantity of the paper under examination was weighed off and first digested in cold, then in hot water, and finally in successive quantities of a boiling solution of tartaric acid in 80 per cent. alcohol, till the fluid failed to yield a turbidity when poured into a large volume of cold water. In this way the resin size is removed. The paper is again washed with hot and cold water, dried and, lastly, extracted with alcohol and ether. It is then boiled up with 20 c.c. of an aqueous solution of gold chloride containing 0·2233 grm. Au., and the reduced metallic gold estimated. It was found that 100 parts of white fine wood yielded 14 parts of metallic Au.

The reducing power of the willow, aspen, elm, Scotch fir, white pine, etc., were found to be nearly alike.

In their investigations they attempted to find means to shorten the method by (1) using other reagents for extracting the resin size, etc., and (2) to use a cheaper reagent than gold chloride. It was found, however, that other reagents, such as Fehling's solution and alkaline solution of tartrate of bismuth, as substitutes for gold chloride, did not act well, and it was finally proved that gold chloride alone gave constant results.

Instead of extracting with water, alcohol and ether, in order to shorten the method, a 10 per cent. solution of ammonia was tried. This withdrew a quantity of encrusting substances from the wood, a brown fluid being obtained, which yielded on evaporation a brown resinous mass. The amount of encrusting substances removed varied in the different kinds of wood, *e. g.*:

Maple wood	11·662	per cent.	ammonia extract.
Poplar wood	13·639	"	" "
Beech wood.....	14·675	"	" "
Scotch fir wood.	4·214	"	" "
Spruce wood....	4·103	"	" "

The wood, after being boiled with diluted ammonia, reduced chloride of gold powerfully. Wood or straw cellulose treated with aqueous ammonia yields a pale yellow solution, and neither of these after such treatment acts upon chloride of gold. The cellulose from linen and cotton behaves in a similar way. A large number of experiments showed that the different kinds of wood pulp extracted with 10 per cent. fluid ammonia exerted a nearly equal reducing power. The results obtained were as follows:

Poplar	1 test	.....	21·34177	per cent.	gold.
"	2 "	.....	21·30285	"	"
"	3 "	.....	21·53870	"	"
Spruce	1 "	.....	20·77594	"	"
"	2 "	.....	21·43874	"	"
"	3 "	.....	21·51431	"	"
Scotch fir	1 "	.....	21·02285	"	"
"	2 "	.....	21·00846	"	"
"	3 "	.....	21·34453	"	"
Maple		.....	21·36700	"	"
Nut tree		.....	21·40700	"	"
Average			21·242	"	"

The gold factor (21·2), as it has been called, is larger when the ground wood pulps are extracted with ammonia than when they are treated with alcohol and ether. In the latter case it is only 14.

Godeffroy gives the following directions for the determination, which occupies about six hours. Two strips cut from the sample of paper under investigation are freed from moisture by drying at 212° Fah. and weighed separately. They are then rolled up and loosely enveloped in platinum wire and boiled with successive quantities of fresh distilled water to remove animal size if this is present. If the paper contains resin size the strips are boiled in a beaker glass with 90 per cent. alcohol containing a little tartaric acid. After this is done they are boiled in a 10 per cent. ammonia solution for about 10 minutes, the yellow fluid being poured off, and this operation repeated with fresh ammonia as long as the liquid is colored yellow. Finally the strips are washed with hot water till all traces of ammonia are removed, and then dried.

One of the strips is used for determining the ash, while the other is used for the wood determination. For this purpose it is boiled with the quantity of gold chloride indicated above, diluted with as much water as will completely cover it. After boiling 10 or 15 minutes the paper with the reduced gold is collected in a filter, washed, dried, ignited in a porcelain crucible and weighed. The quantity of ash found in the paper is deducted from this weight, and the percentage of mechanical wood pulp calculated from the remainder. If "g" denotes the quantity of separated gold in grammes, and "h" the required quantity of wood pulp, then:

$$\frac{100}{21{\cdot}2} = \frac{h}{g};\ i.\ e.,\ h = \frac{100g}{21{\cdot}2}$$

or to obtain the quantity of wood pulp present in grammes, multiply the weight in grammes of gold found by 100 and divide the product by the constant 21·2. From this the percentage can be calculated on the above determined dry weight of the paper.—*Chemical Trade Journal.*

ON METALLIC OSMIUM.

By A. JOLY and M. VEZES.

OSMIUM, as generally obtained by the method of Berzelius, *i. e.*, by igniting the sulphide in a crucible of carbon, is a powder or a spongy mass of a more or less deep blue color, according to its state of division. It is then directly oxidizable in the air, and exhales a very strong odor of osmic acid. H. Sainte-Claire Deville and H. Debray obtained osmium in small crystals of a fine blue tinted with gray by passing fumes of osmic acid into a tube of carbon very strongly heated. The specific gravity of the metal has been successively represented by the numbers 7, 10 and 21·4; the specific gravity of crystallized osmium is 22·48.

H. Sainte-Claire Deville and H. Debray attempted unsuccessfully to fuse osmium by heating it before the oxhydrogen blowpipe in a crucible of coke inclosed in a crucible of lime. If directly heated in the point of the blowpipe flame, the metal disappears rapidly, either by volatilization or by conversion into the volatile peroxide. But even an experienced eye which follows the phenomenon attentively cannot detect in the morsels of osmium as they rapidly disappear the least trace of fusion. In order to solve this question, osmium must be heated in a vacuum by means of a powerful arc. In consequence of its physical and chemical properties, which, however, vary according to the manner of its preparation, osmium approximates to the non-metals. According to Deville and Debray, it is the non-metal of the platinum family. Berzelius assimilates it to arsenic, and Dumas to tellurium.

Perfectly pure osmium may be melted in the electric arc, and obtained in a metallic form comparable to ruthenium. On account of its oxidability, the poisonous character of its vapors, and to avoid losses by volatility, which render the experiments very costly (the lowest price of the metal being 1,500 fr. per kilo.), it is necessary to adopt special arrangements. We operate in a closed apparatus traversed by a slow current of carbonic anhydride and in cupels of coke. If the metal is rapidly raised to the highest temperature of the arc, it melts without being appreciably volatilized.

We succeed badly if we operate in lime crucibles; in contact with the metal, the lime is profoundly converted into a vitrifiable mass, with which the metal remains incrusted.

Melted osmium is very brilliant on the surface; the color is still a bluish gray. Further experience must decide whether the metal is blue just as gold is yellow and copper is red. The fracture is crystalline, harder than iridium and ruthenium; it cuts glass deeply, scratches quartz, but is scratched by topaz; the best tempered files do not cut it. If thus melted osmium is not oxidized in the air at common temperatures.

Osmium as a metal may be compared to ruthenium; these two metals form a very distinct group—like rhodium and iridium on the one hand, and palladium and platinum on the other. The atomic volumes are almost identical.

	Atomic weight.	Specific gravity.	Atomic volume.
Ruthenium	101·4	12·06	8·40
Osmium....	190·3	22·48	8·46

More refractory than all the other metals of the platinum group, they are more readily oxidized, and if heated to redness in oxygen they yield peroxides RuO_4 and OsO_4. They approximate greatly to Mn by their very extensive series of oxides of an acid character.

The double chloride $OsCl_4,2KCl$ establishes the connection of the group with the platinum-palladium group, as well as with iridium. Ruthenium has no corresponding compound. Rhodium is similarly situated, and the compound $PtCl_4,2KCl$ is not stable. The tetrachloride and its derivatives, so characteristic of platinum, are merely an exception for the three metals of the group, the atomic weights of which are comprised between 101 and 106. The double sesquichlorides $Ru_2Cl_6,2KCl$ and $Os_2Cl_6,2KCl$ connect them by rhodium and iridium.—*Comptes Rendus*, cxvi., No. 11.

RAPID CRYSTALLOS.

By CH. SCOLIK, Vienna.

THE rapid developer known under this name and put in market by the Paris firm, Crystallos, and myself, has the decided advantage that it is the most energetic of all known developers. The analyses published by several parties, in which they assert that it was a mixture of hydroquinone and eikonogen, are entirely wrong, the composition of this developer, never published before, being the following:

Sulphite of soda.....	230	grms.
Yellow prussiate of potassium.....	80	"
Hydroquinone.....	45	"
Caustic potash (83 per cent.).....	67	"
Distilled water.....	800	c. c.

The preparation of the developer takes place best in such a way that the three first-mentioned substances are dissolved together in 600 c. c. water by application of heat, while the caustic potash is dissolved in a separate dish in 200 c. c. of cold water. Both solutions are then mixed together, left to cool off, and filtered. If it is desired to give the developer a reddish appearance, same as the Paris "Crystallos," although this is of no importance whatever, a pinch of red aniline color, for instance, "phloxin," is added before filtering.

For plates of short exposure the developer is diluted with three times the quantity of water; for plates of longer exposure, with five to eight times the quantity of water. Bromide of potassium solution, 1:10, serves as a retarder. The picture appears with extreme rapidity and of great density. As soon as the edges of the plate begin to show a gray fog, the development has to be interrupted quickly. By too long

an action of this developer upon the plate, for instance, when under-exposed, a yellow fog will form. The same also appears if the negative was washed badly after developing.

This developer is particularly suitable for instantaneous views. It can be applied several times in succession without losing its energy. The old developer is preserved and can be applied until it is exhausted. A disadvantage of the developer is that in consequence of the caustic potash the film is loosened and affected somewhat, and that it makes the hands very slippery. —*Anthony's Bulletin.*

THE EFFECTS OF ALLOYS ON THE MECHANICAL AND PHYSICAL PROPERTIES OF METALS.†

By Prof. W. C. ROBERTS-AUSTEN, C.B., F.R.S.

IN presenting a second report to the Alloys Research Committee, it may be well to state briefly the nature of the investigation intrusted to me, and the conclusions to which the previous work had led. The main object in view was to extend a research I had previously made upon the application of the periodic law of Newlands and Mendeleeff to the mechanical properties of metals. This law, as originally expressed, states that "the properties of the elements are a periodic function of their atomic weights." It had already been shown that the effect of impurities added to gold is nearly proportional to their atomic volumes, the larger the volume of the atom the greater being its effect; and the question was, does this hold good for other metals? It was manifest that the most important evidence which could be gained was that relating to the thermal disturbance which accompanies any molecular change; and, as this usually occurs at high temperatures, it was necessary to develop and perfect the methods which were available for measuring them, and for recording the results.

The first report therefore dealt with the description of certain new methods and appliances that had been adopted in conducting the inquiry, the most important being a photographic method of pyrometry. Further details respecting the pyrometric methods adopted will be found in the present report. Before proceeding, however, to describe the experiments that have been made, I would direct attention to some further considerations which seem to point to the possibility that the influence of small quantities of added elements on the mechanical properties of masses of a metal will be in proportion to the atomic volume of the impurity.

In the first place it must be borne in mind that the researches of Raoult,‡ and the conclusions of Van 't Hoff§ and Arrhenius,‖ lead to the view that the molecules of small quantities of elements distributed through a mass of a solvent retain their individuality; that is, they remain free, and do not enter into combination with the mass. As regards metals, the work of Heycock and Neville,¶ as well as the results of experiments described in the previous report,** point to the conclusion that the added elements may retain their freedom when they are present in much larger quantities than 0·2 per cent., which is the amount of added matter usually dealt with throughout the present series of researches. No pains were spared in making this point clear. It will be evident, however, that the question whether the added element does or does not remain free in the mass of the solvent is a vital one in limiting the scope of this inquiry.

If the added element enters into combination with the solvent, its individuality will be changed, and it may well be that the mechanical properties of the metallic mass will mainly depend on the degree of fusibility of the compound which is formed. If the concentration of the solution is such that a fraction of the dissolved body alone remains isolated, the influence of the volume of the added element will evidently be disturbed, as this influence is supposed to be exerted only by a single constituent of the mixture, while the mechanical properties of a solidified mixture are functions of both constituents.

In the favorable circumstances, however, where the solvent is not saturated by the added element, and where the law of atomic volumes is applicable, the work of Sorby and of Osmond has shown that a metal is seldom homogeneous, but is more often formed of rounded polyhedral grains; and the cohesion in the interior of a grain differs from the adherence between the two neighboring grains.

The law of atomic volumes cannot apply to the adherence of the grains, which is regulated by other causes, such as the rate of cooling and the pressure, and whether a compound is formed which solders the grains together. It follows that, in an attempt to prove the nature of the influence of atomic volumes by mechanical tests only, anomalies and more or less grave irregularities will be met with. Experience shows that this is actually the case. If the appeal were only to mechanical tests, the position of those who think that the influence of the impurity is proportioned to the volume of its atom would not be a very firm one; but there is no such limitation.

The series of experiments on bodies alloyed with iron, to which reference was made in the previous report, demonstrates that, independently of all mechanical tests, the influence of impurity on the molecular transformations in iron, studied by Osmond, may be shown in several ways. These transformations may be assisted by the presence of impurity, the temperature at which they occur may be altered, or the molecular changes may even be entirely prevented by the presence of elements which behave in strict accordance with the law of atomic volumes. The thermal displacement of the critical points of molecular change —the α and β points in iron, for instance—may be produced at will; and the nature of the effect of added elements on iron may be predicted in cases which have not as yet been studied. It may be urged that the behavior of iron is peculiar and special, but this is improbable.

† Second Report to the Alloys Research Committee, presented to the Institution of Mechanical Engineers, April 20, 1893.

‡ *Comptes Rendus*, vol. lxxxvii. 1879, p. 167.

§ *Philosophical Magazine*, 1888, series 5, vol. xxvi. p. 81.

‖ *Philosophical Magazine*, 1888, series 5, vol. xxvi. p. 90.

¶ *Journal* of the Chemical Society, 1889, vol. lv. p. 666; 1890, vol. lvii. pp. 376 and 656; 1892, vol. lxi. p. 888.

** *Proceedings* 1891, p. 543.

It must be borne in mind that the view originally set forth, namely, that traces of elements influence masses in proportion to the volume of their atoms, is new, and if it be true, is of great importance in molecular physics. It will be well, therefore, to consider what evidence other observers have obtained as to the influence of the atomic volume of a mass of metal on its mechanical properties. H. Tomlinson* has shown that the thermal capacity of metals closely follows their atomic volume; while as regards their elasticity, he gives a table† showing the relation of Young's modulus to the atomic volume; and after considering the work of Wertheim,‡ of Maxwell, § and of Heen,‖ he concludes on experimental evidence of his own that the value of the product of the elasticity, E, when multiplied by a fractional power of the atomic volume $\frac{A}{D}$, is constant for metals, or $E\left(\frac{A}{D}\right)^{\frac{1}{3}} = 181 \times 10^{8}$;

and that the divergences shown by several metals from this mean value arise from the fact that the presence of small amounts of impurity makes an enormous difference in the elasticity. Sutherland¶ shows that the rigidity of metals bears a close relation to their atomic volumes; and points out that the rigidity of metals "in its essence is a kinetic phenomenon almost as simple in character as the elasticity of perfect gases." And Professor Fessenden,** while holding that the cohesion of metals is proportional to some power of their atomic volumes, seems to conclude that their rigidity varies as the fifth power of the distance between the centers of the atoms, or as (atomic volume) $\frac{5}{3}$.

One other fact deserves notice. Mons. T. Werth has quite recently urged†† that in the production of the diamond form of carbon, which Mons. Moissan has shown can be effected artificially, the three factors are: (1) pressure, (2) rate of cooling, and (3) the simultaneous presence, in the metallic mass from which the diamond separates, of some body which has a smaller atomic volume than that of the carbon. Mons. Werth states‡‡ that the effect of pressure, in enabling a body to pass from its normal form to an allotropic condition, has been indicated by me; and that the influence of the presence of a body of small atomic volume has also been indicated by me, and studied, in the case of iron, by Osmond. As regards the influence of an element of small atomic volume, he considers that, in the separation of the diamond form of carbon from iron, this condition is met by the presence of hydrogen. The influence of pressure in determining the state of a mass of a metal or alloy is still further examined in the present report.

Molecular Porosity.—A remarkable series of experiments has recently been made by E. Warburg and F. Tegetmeier,§§ which would seem to demonstrate the possibility of producing eventually a degree of porosity in vitreous bodies which will admit the passage of elements having comparatively small atomic volumes, while other elements having larger atomic volumes are strained off, thus occasioning a mechanical sifting of the elements. A receptacle was divided by a sheet of glass which could be several millimeters thick. Sodium amalgam was placed on one side and pure mercury on the other; the whole was then heated to a temperature of 200° C. or 400° Fah., at which the glass becomes slightly conducting. By the aid of a Planté battery, the sodium atoms of the sodium silicate present were set in motion; and after the experiment had continued thirty hours it was found that a considerable quantity of sodium, amounting to 0·05 gramme or 0·77 grain, had passed into the mercury, which was originally pure. A corresponding amount of sodium had been lost by the amalgam; but the glass had exactly preserved its original weight and clearness. The glass was partly composed of neutral molecules of sodium silicate, together with free molecules both of sodium (base) and of the acid and the free sodium capable of being transported under the influence of the electrical current.

When, however, Tegetmeier replaced the sodium amalgam by lithium amalgam and repeated the experiment, the sodium of the glass passed as before into the original pure mercury, and the glass became opaque on the side touching the lithium amalgam; but after a time the opacity extended right through the thickness of the glass, and then metallic lithium began to accumulate in the previously pure mercury. It is not possible thus to chase out all the sodium present in the glass; but the free sodium atoms are replaced by those of lithium. Analysis showed that the glass originally contained 2·4 per cent. of potassium and 13·1 per cent. of sodium; but after the experiment, while retaining the same percentage of potassium, it had 4·3 per cent. of lithium and only 5·3 per cent. of sodium. The glass in which lithium has thus replaced part of the sodium is very tender, and is opaque and friable. The conclusion is that the atoms of lithium, having an atomic weight of 7 and an atomic volume of 15·98, can pass along the cracks or molecular galleries left in the glass by the sodium atoms, the atomic weight and volume of which are 23 and 10·04 respectively.

When a metal of superior atomic weight and volume to sodium is substituted for the lithium—such as potassium with atomic weight 39 and atomic volume 24—it is found not possible to chase out the sodium, the new atoms being too big to pass along through the spaces where the sodium had been. We are thus confronted with a molecular porosity which can in a sense be gauged; and the mechanical influence of the volume of the atom is thus made evident.

It will be evident that there is a direct connection between the properties of a mass and the volume of its atoms. In all probability, therefore, the introduction of free molecules of an added element must create a disturbance, the nature and magnitude of which will bear some relation to the volume of the disturbing atoms. In the present inquiry, which is conducted essentially from the engineer's point of view, great prominence must be given to mechanical tests, upon the results of which the employment of materials depend. This fact was remembered in conducting the following experiments on the effects of certain impurities on copper, which was one of the three metals specially selected by the research committee as the subject of experiment.

Influence of Impurities on Copper.—Copper is a favorable metal for study, because its industrial applications are many and varied, while its mechanical properties are known to be strangely affected by the addition of foreign matter. The results already obtained with iron at once suggest the question whether copper is a metal whose ultimate atoms are capable of arrangement in different ways in the molecule. Can normal copper be made to assume an allotropic state, analogous to that in which there is reason to believe iron can exist? If it can, are the properties of normal and of allotropic copper as widely different from each other as are those of the distinct varieties of certain well known non-metallic elements? There seems to be little doubt that copper can be prepared by electrolytic deposition in an allotropic state, in which the density of the metal is from 8·0 to 8·2, compared with 8·92, which is that of normal copper; the allotropic variety also shows a readiness to undergo chemical change which is not shared by ordinary copper. The evolution or absorption of heat, however, during gradual cooling or heating, which is evidence of marked reversible thermal effects and is a main indication of molecular change, is not so easy to detect in copper as it is in iron which is being gradually cooled or heated.*

On the other hand, it is held in the case of iron that subjecting the metal to any mechanical stress† which tends to produce permanent deformation of the mass enables the iron to assume an allotropic form. In this respect the purest obtainable copper seems to be singularly insensitive, inasmuch as its subjection either to stress, which deforms the metal, or to annealing, the tendency of which is to reverse the effects of mechanical stress, is accompanied by profound changes in the mechanical properties. It is impossible to say, for instance, what the standard tenacity of a normal sample of pure copper should be taken to be, as so much depends on the previous history of the piece of metal, especially as regards the mechanical and thermal treatment to which it has been subjected.

The following figures will show how great the variations may be. Rods of very pure electrolytic copper, all the same sample but variously treated, broke under the following stresses:

Treatment of Copper Rods.

	Breaking stress per square inch.		
	Lb.		Tons.
Cast rods 0·2 inch diameter	18,410	=	8·219
Cast rods carefully worked and annealed	40,900	=	18·259
Cast rods carefully worked at the ordinary temperature and annealed by slow cooling from a red heat	31,710	=	14·156
Cast rods heated to a temperature of 800° C. or 1470° Fahr. and quenched in water three times	25,400	=	11·339
Cast rods worked (or forged) and not annealed	42,000	=	18·750

The experiments entirely confirm the results obtained in this country by Mr. Parker,‡ and by Professor Unwin,§ and by Mons. Andre le Chatelier;‖ but, as the latter points out, the tests by Mr. Parker and by Professor Unwin appear to have been made on unannealed copper, and the results are applicable only to the particular specimens subjected to examination. Mons. A. Le Chatelier has moreover called attention to the fact that the time during which the metal is annealed has a marked effect on the tenacity. A consideration of these facts shows the great difficulty of determining what should be the standard tenacity of copper; and this is well illustrated by the results obtained by the American committee appointed many years ago to investigate the properties of the alloys of copper and tin.¶ Even if a standard tenacity could be fixed, it would be very difficult to obtain a sufficient quantity of copper of a standard degree of purity for the purposes of a lengthy inquiry.

After many difficulties and fruitless trials, the author adopted pure electrolytic copper cast in thin rods, as the material which formed the basis of the experiments; and in the preparation of these rods the following plan, suggested by Mr. Jenkins, was followed. There is usually great difficulty in making small castings of copper, owing to the rapidity with which oxidation proceeds when the liquid metal is exposed to the air, as it is when poured into a mould. Moreover, as old and well known experiments have shown, the strength of copper is singularly affected by the presence of small quantities of dissolved cuprous oxide; and it becomes absolutely necessary, in studying the effect of single elements upon copper, to exclude the simultaneous presence of cuprous oxide. In order to insure this, the molten metal was not brought into contact with the air at all, but the moulds formed part of the crucible in which the metal was melted.

Tubes were prepared by drilling out long rods of electric light carbon from one end, a certain thickness of solid material being allowed to remain at the opposite end, through which a fine hole was subsequently made. The weighed amount of pure electrolytic copper was placed in a crucible sufficiently large to leave an inch of its height to spare, beneath the plug or lid into which the tubes were fixed. Seven tubes were usually employed for each set of castings. The carbon tubes with their open ends downward were placed vertically in the center of the crucible, and packed in with fire clay; the whole was carefully dried, and when ready was placed in a furnace with a deep fire. When the copper was thoroughly melted, the crucible was lifted out, and then inverted, so as to cause the copper to flow into the carbon tubes. A little copper was allowed

* *Proceedings* of the Royal Society, 1885, p. 485.

† *Philosophical Transactions* of the Royal Society, 1885, p. 32.

‡ *Annales de Chimie*, 1884, vol. xii.

§ *Philosophical Transactions* of the Royal Society, 1885, vol. cxxvi. part 1.

‖ *Bulletin* de l'Academie Royale de Belgique, 1892, vol. lv.

¶ *Philosophical Magazine*, August, 1891, p. 41.

** *Chemical News*, vol. lxvi., 1892, p. 206.

†† *Comptes Rendus*, vol. cxvi., 1893, p. 323. (A paper sent to the Academie des Sciences, January 31, 1893.)

‡‡ *Comptes Rendus*, pp. 218, 458 and 460.

§§ *Wiedemann's Annalen*, vol. xli., 1890, pp. 1-41. E. Warburg, Galvanische Polarization. F. Tegetmeier, "Ueber die electrolytische Leitung des Glases und Bergkrystalls." Also *Revue Generale des Sciences*, 1890, p. 515.

* Schutzenberger, *Comptes Rendus*, vol. lxxxvi. 1878, pp. 1265 and 1397.

† Osmond; Carus Wilson, *Philosophical Magazine*, 1890, series 5, vol. xxix. p. 200; Barus, *Nature*, vol. xli. 1889-90, p. 369.

‡ *Engineering*, vol. xlvi. Aug. 3, 1888, p. 125.

§ Reprint from *Le Genie Civil*, 1891.

‖ British Association Report, 1889, p. 746.

¶ Report on the Alloys of Copper and Tin, 1879, p. 456.

to flow out of the fine holes in the outer ends of the tubes; and these holes were then stopped by placing the tubes upright in a bath of sand. In casting the bars containing impurity, a rich alloy of known composition was made in the first instance; and a weighed amount of this alloy was added to the charge, which latter was well shaken when melted.

In the preparation of the copper rods, they were first carefully and evenly hammered, until they were somewhat flattened. They were then heated to redness for a few minutes, and plunged into cold water, and hammered until they were of square section. They were again heated to redness and quenched, and then hammered until they were octagonal. They were finally brought to an approximately circular section by passing them through grooved rolls. After a third heating and quenching, their diameter was measured by means of a micrometer, and marks were made at every half inch of their length. They were then ready for testing. If they were required to be tested at any other temperature than that of the room, a thermo-junction of platinum and platinum-rhodium wires was firmly tied down to the specimen by means of a short spiral of soft copper wire; and the whole was inclosed in a thick copper cylinder of sufficient length to fill the space between the jaws of the testing machine. The ends of the tube were lightly packed with asbestos fiber, so that, while air currents were prevented, the tube formed a small air bath around the specimen. The tube was very slowly heated by ordinary gas burners, until the desired temperature was reached at which the test had to be made; the gas supply was then moderated until the temperature was quite steady, and when this was the case the load was applied. The test pieces were loaded at such a rate that fracture occurred in about fifteen minutes from the first application of load.

This copper was analyzed by one of my own students, Mr. Allan Gibb, who has devoted much care and attention to this particular portion of the investigation. It was found to be singularly pure, containing 99·99 per cent. of copper. Neither lead, silver, antimony, arsenic, tin, iron, nickel, sulphur, nor phosphorus could be detected, though they were carefully sought for. On the other hand, a minute trace of bismuth was detected. The method of analysis adopted is given in the appendix. The electrical conductivity of this metal after annealing was very high; tested by Mr. W. Gowland, a well known authority upon the subject, it proved to be 102, pure copper being usually 100 or 101.

(To be continued.)

PHILLIPS' FLYING MACHINE.

IN the many attempts which have been made to solve the problem of aerial navigation, the principle most in favor of late years has been that of large plane surfaces. Upon this principle for some twenty-eight years past Mr. Horatio Phillips has worked, until at length he has succeeded in demonstrating that the principle is fundamentally correct. But he has reduced the dimensions of his planes from some 4 or 5 ft. broad to those of Venetian blind laths, much to his advantage. His method of proceeding in fact is entirely different from that hitherto pursued by others working in the same field, as neither large plane surfaces nor balloon arrangements are employed, nor is stored-up energy used. Advantage is taken of a vacuum and a plenum formed by induced currents on the upper and under surfaces respectively of a series of slats or laths fixed horizontally in a vertical frame. These slats are curved on their upper and under surfaces and are thicker at their leading edge than at their trailing edge. The curves are such that the convex upper surface near the front edge deflects the air upward, thus creating a partial vacuum on the upper surface of the slat or sustainer. The under surface of the slat is formed to a parabolic curve which gradually puts the particles of air into motion downward, thus producing an excess of pressure on the under surface of the slats. The principle has been put into practice by Mr. Phillips in a machine which broadly resembles a canoe with a sail like a Venetian blind with the slats fixed wide open, the machine being driven forward by an air propeller to which motion is given by a steam engine.

The carriage is 25 ft. long and 18 in. wide, tapering to a point at the front end. It is borne on three wheels a foot in diameter, one in front and two at the rear. There are 50 sustainers or slats, each 1¼ in. wide and 22 ft. long, fitted 2 in. apart in a frame 22 ft. wide and 9 ft. 6 in. in height. The sustainers have a combined area of lifting surface of 136 sq. ft. The boiler is a cylindrical phosphor-bronze vessel 12 in. in diameter and 16 in. in length. The heating surface is 12 sq. ft., and is made up of Field tubes ¾ in. outside diameter and 14 in. long. The fire grate area is 70 sq. in., and the fuel used is Welsh coal. The engine is compound, having cylinders 1⅝ in. by 3⅝ in. by 6 in. stroke, fitted with ordinary slide valves. The working pressure of steam is 180 lb. per sq. in. The propeller is 6 ft. in diameter and 8 ft. pitch, and has a projected area of blade surface of 4 sq. ft. The speed is about 400 revolutions per minute, and the estimated speed of the machine about 35 miles an hour. The weights of the various parts of the machine are approximately as follows: Carriage and wheels, 60 lb.; machinery complete in working order, with water in boiler and fire on grate, 200 lb.; sustainers, 70 lb.; total weight of machine, 330 lb.; total weight lifted and carried, including 72 lb. of added weight, 402 lb.

In order to test the machine a wooden track 628 ft. in circumference and about 6 ft. wide has been laid in the gun proving grounds of Messrs. Cogswell & Harrison, at Harrow, the machine being tethered to a central post. In some trials which we recently witnessed a number of runs were made, with the result that a speed of 28 miles an hour was attained. As regards the ascensional powers of the machine, it was shown that it had a lift of about 3 ft. from the ground at the rear. The rise reached its maximum when the machine ran in face of the wind, and was continued over about two-thirds of the track. The machine was also moored by a stern rope in which a dynamometer was inserted, and on the engine being run at full speed, the dead pull was 75 lb. On the whole the machine is one of promise, and is certainly a step in advance in aerial navigation. We take the foregoing from *Iron*. We are indebted to *Engineering* for the accompanying illustrations and particulars. Of the four views, two show the machine in the act of flying, it being lifted from 2 ft. to 3 ft. off the ground. Our illustrations are, of course, from photographs, and it will easily be understood how difficult it is to photograph a piece of mechanism of this description, moving at so high a speed, when close to. The aerial propeller itself is not visible, the motion being too quick, the revolutions per minute being about 600. Fig. 1 shows the "whirling machine" which Mr. Phillips has used in the course of his numerous experiments in order to ascertain the best form of slat or sustainer, while in Fig. 2 the flying machine is seen at rest.

We have seen another aerial machine of Mr. Phillips' in operation, the same engine and boiler, however, being used. In this latter trial the weight of 72 lb. was lifted clear of the track; but the distance which the machine flew was not so great as on the first trial we witnessed, and this in spite of the fact that the day was more favorable, there being less wind, the travel of the breeze being probably about 10 miles an hour. From this it may be argued that Mr. Phillips has not improved the first machine we saw, by the modifications he has introduced. The chief alteration was an addition to the area of sustainer surface, and Mr. Phillips is of opinion that he has gone beyond the limit of the power at his disposal with the present propelling mechanism. The slats or sustainers in the last machine were also placed at a slight angle, while the first were entirely horizontal. This had the effect of reducing the speed and therefore the efficiency of the surfaces. The speed which Mr. Phillips has in view to commence with is 40 miles an hour, and in order to reach this speed lighter propelling machinery will be required. At present Mr. Phillips has turned his attention more especially to the sustainer surfaces. Although the engine is a very nice specimen of mechanical work, much might be done in lightening this part of the apparatus, especially in regard to the boiler. Mr. Phillips is now turning his attention to this part of the problem, and hopes soon to show considerably higher results. The interesting point, of course, will be

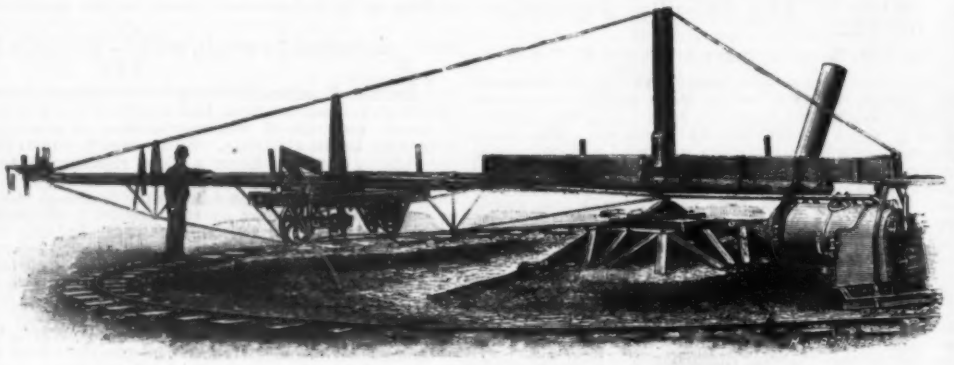


FIG. 1.—EXPERIMENTAL WHIRLING TABLE.

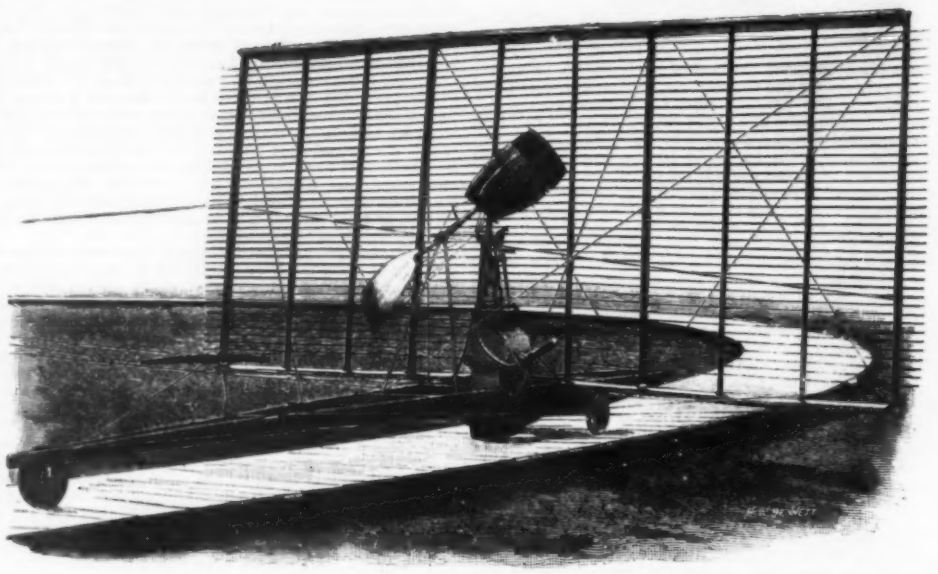


FIG. 2.—FLYING MACHINE AT REST.

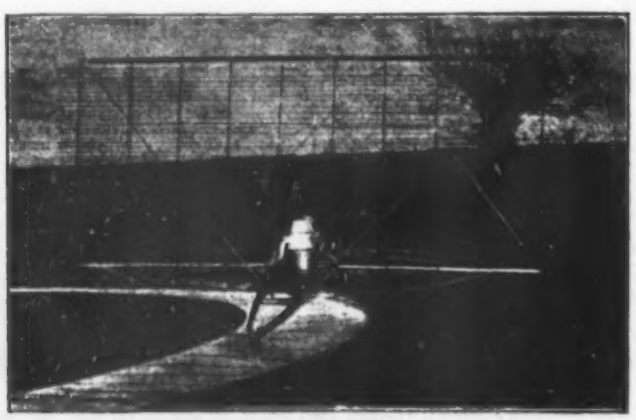


FIG. 3.—MACHINE IN MOTION—FRONT VIEW.

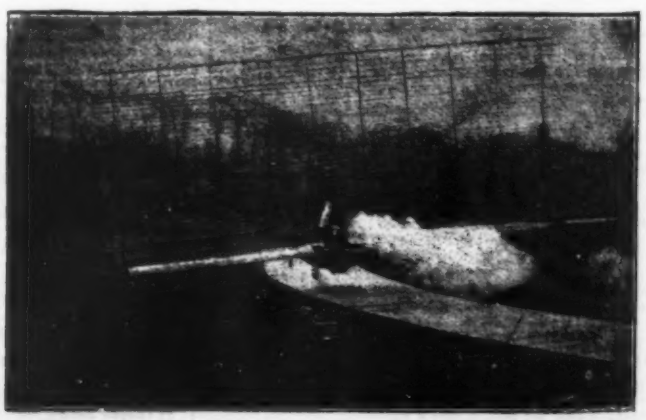


FIG. 4.—MACHINE IN MOTION—REAR VIEW.

PHILLIPS' FLYING MACHINE.

reached when an apparatus large enough to carry an operator has been constructed. Another detail to which attention has been turned is the leveling of the circular track on which the machine runs; this was known to be somewhat out of truth, but on testing it was found that there was a difference of 4 ft. 6 in. in the level of the two sides; this has now been put right. Since our notice appeared, a large number of persons interested in these matters have paid a visit to Mr. Phillips' trial ground, and the operations are being watched with great interest by all persons connected with aeronautical matters.

A word should be said about the whirling machine. As will be seen, it consists of a spar pivoted near one end, the balance being obtained by a locomotive boiler of about 10 horse power, which is mounted on the short arm of the spar. The engine which drives the apparatus is on a two-wheeled carriage running on rails. The engine, which is attached to the long arm of the spar, not far from the pivot, runs round on a circular rail, and carries the spar with it, the steam being conveyed from the boiler to the engine by a pipe running on the spar. Beyond the carriage there projects a long arm, the end of which sweeps through a large circle; by this a rapid motion is obtained. The circle is 323 ft. in circumference, and a speed of 70 miles an hour is thus often obtained. The slats or sustainer surfaces to be experimented on are, of course, placed at the end of the spar, and connected to an apparatus by which the weight lifted and the power required to tow the surfaces through the air are automatically registered.

LA COUR'S "KRATOSTATE."

MR. PAUL LA COUR, a Danish inventor, whose "phonic wheel" has been adopted in various countries, has recently added another ingenious appliance to those already due to his inventive talent. This is a governor to which he has given the name "Kratostate."

The construction of the Kratostate and the principle on which its action depends are shown in Fig. 2 herewith. A and B are chain wheels, the former being connected with a belt pulley and driven by the machinery which has to be regulated, while B is connected with a worm wheel and worm driving a small fan, F. D and E are chain wheels fixed to the two rods, D^1 and E^1. An endless chain passes round these four wheels, and a suitable weight is attached to D in order to keep the chain taut. A weight, L, applied to E will, when kept balanced by the pull at A, maintain the speed of the fan, F, constant. The lever, R, is fulcrumed at *r* and connected with the rod, E^1, the movement of which it is bound to follow in such a manner that when raised it will decrease the normal speed of the machinery, and when lowered will increase it. By altering the weight, L, it is an easy matter to vary the speed of the machinery, while a minimum difference in speed will with difficulty influence a centrifugal regulator, it being too small to overcome the resistance of regulation. Even an insignificant variation in speed will soon bring about such a difference in the distance covered by the wheels, A and B, that a regulation will be effected.

The Kratostate, upon the perfection of which Mr. La Cour has been engaged several years, and for which purpose he has received an annual grant from the Danish government, has been thoroughly tested. Besides being used as regulator for steam engines, it has also been adopted as an independent regulator for other particularly irregular and variable producers of power, such as windmills.

As a governor for marine engines, Mr. La Cour has made the Kratostate of special construction, and it is claimed that the action is such that the steam is cut off even before the propeller is raised entirely out of the water, and that it is able to open the throttle valve at the exact moment when the water again offers resistance to the propeller. The worm wheel shown in the illustration (Fig. 1) is worked by the engine and drives a worm. This worm has its bearings placed on a lever or balance, and carries an air propeller, the resistance to rotation of which produces pressure on the balance. The pressure increases with the speed of the engine, and a movement of the balance takes place. Any fluctuation in the output required of the engine will instantaneously cause a movement of the throttle valve, so as to make the movements of the balance independent of the rolling of the steamer; the worm with its bearing and air-propeller is counterbalanced by a weight on the opposite end of the lever in such a way that the balance has its center of gravity in the axis of its spindle. The Kratostate for marine purposes has also passed out of the experimental stage, and has been severely tested on the s.s. Skjalm Hvide, of Copenhagen, in a heavy sea for a period of fifteen hours, during the whole of which time it is stated to have worked admirably.—*Industries.*

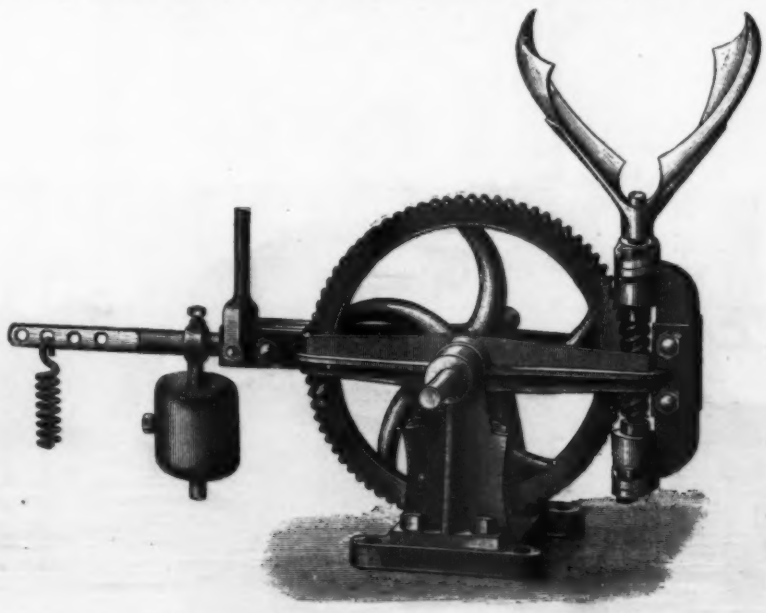


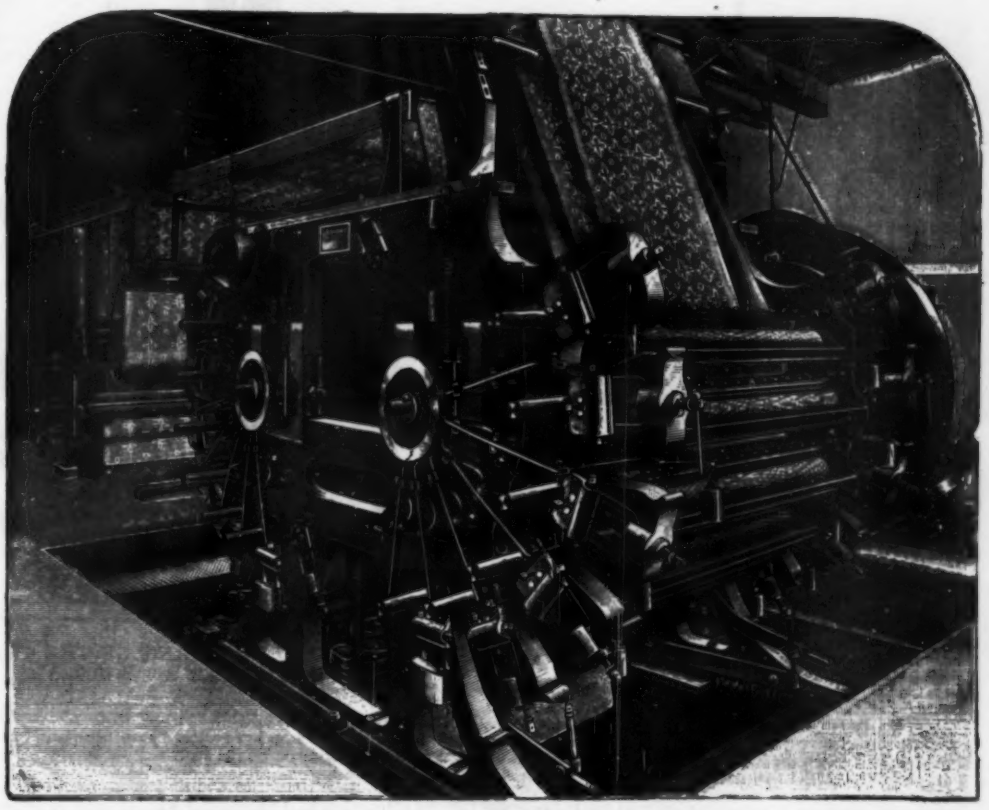
FIG. 1.—"KRATOSTATE" AS CONSTRUCTED FOR MARINE PURPOSES.

DUPLEX COLOR PRINTING.

THIS machine has been designed, patented, and constructed by Mr. John Wood, Railway Foundry, Ramsbottom, for printing both sides of woolen, cotton, or other fabrics simultaneously. Before the introduction of the Duplex machine the printing of both sides of the piece was a tedious and expensive process, as the goods having been printed on one side and dried were again wound on and printed a second time on the other side. Not only was this expensive, but the goods were liable to become damaged or stained in the frequent operations of winding on, printing, drying, etc. The Duplex machine prints the patterns on both sides of the piece in perfect register, or six colors can be printed in different patterns on each side of the piece in one operation. The machine is working satisfactorily in several printing establishments in Lancashire, and the calico printer, by adopting it, is in a position to produce any style of work desired in one continuous operation.

We give an illustration of this invention.

The machine consists of two iron cylinders about 5 ft. wide and 5 ft. diameter, supported by massive cast iron framework, to which are fitted the necessary brass steps and fixings for carrying the printing rollers, doctor shears, color boxes, and traverse motion. The cylinders are placed in a horizontal position, and the pieces to be printed are placed behind the machine, and, when the latter is set in motion, are drawn under and over small copper guide and tightening rollers to regulate the tension of the pieces and grays. One of these rollers is placed near to the bottom of the first cylinder, and as the pieces pass over they are kept free from scumps and prevented from becoming pulled or irregular as they enter the first nip. It will thus be understood that every precaution has been taken in detail to insure the goods being perfectly printed. As the first piece enters the first cylinder it passes around and receives six impressions on one side, then under the second cylinder, where it receives six impressions on the other side, the printer at the same time keeping the patterns in accurate fit. After being printed, they are drawn up and over the drying arrangement by suitable drawing rollers. This drying arrangement consists of a series of copper cylinders and a number of cast iron steam chests. The cylinders are made with steel ends, and, owing to their lightness and strength, are a great improvement upon cylinders with



DUPLEX COLOR PRINTING MACHINE.

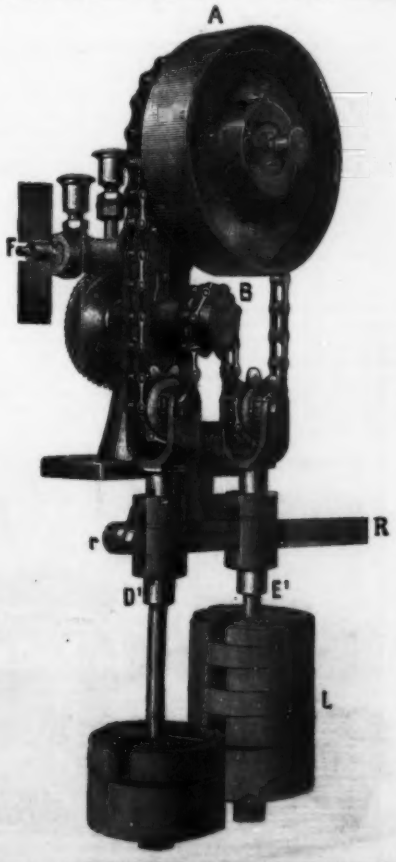
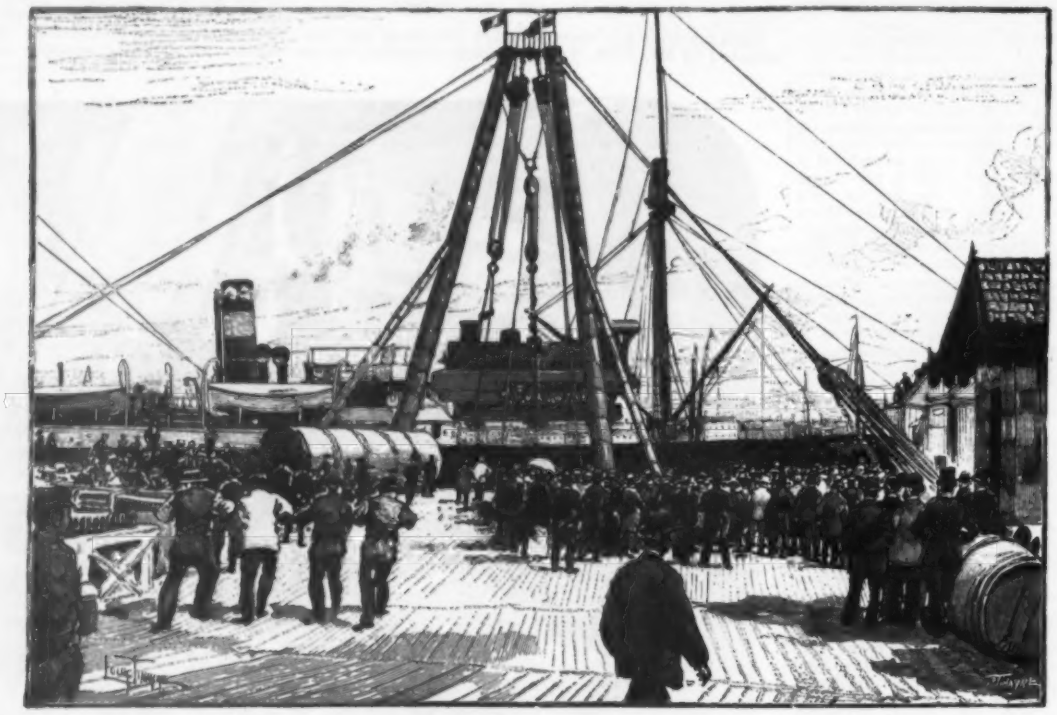


FIG. 2.—APPARATUS AS CONSTRUCTED FOR LAND PURPOSES.

LA COUR'S "KRATOSTATE."

cast iron ends. The cylinders and rollers connected with the drying arrangement are driven by a chain motion from a pulley fixed on a shaft turned by the printing machine, and is so arranged that the speed of each line of cylinders for the printed piece or gray can be varied to suit the tension of the different kinds of cloth and prevent the printed design from being pulled or disarranged during the drying process. There is an ingenious mechanical device by which the printed piece can be drawn up from the printing machine, turning the cylinders at the same time, without interfering with any gearing or other driving arrangement.

In ordinary printing machines the printed piece and gray pull the cylinders round by the action of the drawing rollers attached to the plaiter; by this system the pieces were frequently damaged, and when the cylinders were allowed to stand a short time they became filled with the condensed steam, causing them to stop working, and, on the printing machine being started, these cylinders were full of water and could not be set in motion; consequently, the cloth being dragged round the hot cylinders not in motion, the printed parts became smeared, and the colors were found to have lost their brilliancy and had a glazy appearance. Often the stoppage of the cylinders was a serious loss to the printer, owing to their liability to collapse or explode. By the systems adopted by the patentee of the Duplex machine these difficulties have been overcome, and the drying of the printed pieces and gray can now be conducted on a satisfactory and economical principle. All the rollers for guiding the printed pieces and gray over the drying cylinders and steam chests are made of copper, and are placed in necessary positions, so that the cloth receives as much heating surface as desired. At the end of the drying arrangement is a pair of drawing rollers with an improved plaiter for plaiting the printed pieces into wagons or upon a wooden stage. The blanket rollers are made of strong wrought iron tubing securely fixed on iron ends and shafts. All styles of work can be printed on the patented Duplex machine, and, by a slight alteration in the gearing wheels and a change in the threading of the blanket, the machine can be used as an ordinary twelve-color.—*The Dyer and Calico Printer.*



THE WORLD'S COLUMBIAN EXPOSITION—LOADING OF THE FRENCH LOCOMOTIVE ON BOARD THE STEAMER AT BORDEAUX.

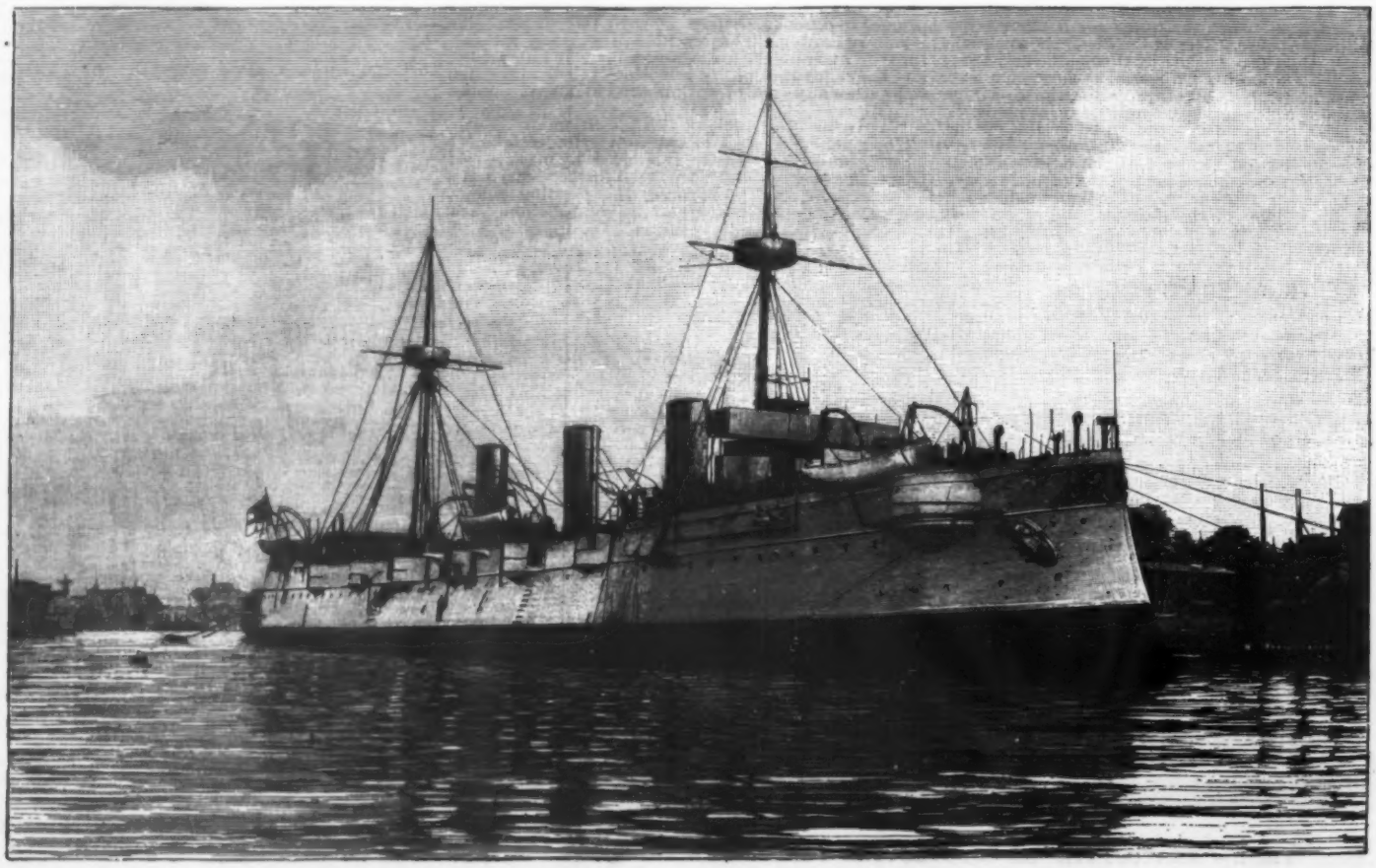
FRENCH LOCOMOTIVES AT THE COLUMBIAN EXPOSITION.

THE exhibits of foreign locomotives at the Columbian Exposition is quite imposing. England is well represented, and so is France. Our engraving shows the transfer of the great French locomotive to the steamer Panama at the port of Bordeaux.

GERMANY'S REPRESENTATIVES AT THE COLUMBIAN INTERNATIONAL NAVAL REVIEW IN AMERICA.

GERMANY was represented at the naval review by two model vessels—the armored corvette cruiser Kaiserin Augusta and the cruiser Seeadler.

The corvette cruiser Kaiserin Augusta, then the fastest and finest vessel of the German navy, was built in the yards of the Schiffs und Maschinenbau-Actiengesellschaft Germania, at Kiel, and was launched on January 15 of last year, being christened by Prince Henry. Being the first vessel with three screws, it has justly attracted much attention. Its proportions are similar to those of the armored cruisers Irene and Prinzess Wilhelm, but the Kaiserin Augusta is much larger and has more powerful engines. The latter are arranged in three separate water-tight compartments, and together produce 12,000 horse power—a power that has never before been developed by any of the large German iron-clads, 10,000 horse power being the highest amount produced by any of them. Each of the three expansion engines drives a screw, so that by working one screw the ship can move slowly; with two in operation its speed is moderate, and when under full head of steam it uses all three screws. In the latter case the corvette can attain the enormous



THE GERMAN ARMORED WAR SHIP KAISERIN AUGUSTA.

speed of 21 to 22 nautical miles per hour, thus surpassing the fastest transatlantic steamers of the Lloyds and Hamburg lines, whose greatest speed is 20 miles. The armament and the interior arrangements are also of the best and newest. The vessel is provided with not less than 20 new, powerful guns, including eight quick-loading Krupp cannon of the newest caliber and five torpedo tubes. The corvette is protected by an armor deck that is almost horizontal, being only slightly arched. The interior arrangements are practical and comfortable, and electrical light is provided for this part of the vessel, as well as for the search lights. In spite of its great size, its shape is graceful, making a most favorable impression. It could be easily picked out from a thousand vessels on account of its three smokestacks, which are flanked on both sides by battle masts, and stand out effectively from the snow-white body of the cruiser. Vessels of similar types have been built, but only as an experiment, by France and North America. Captain Buchsel was appointed by the naval department to command the vessel and her 427 men.

The cruiser Seeadler, which accompanies the Kaiserin Augusta, has also donned the white garment of the tropics, thus displaying her elegant form to better advantage. This cruiser was built as a substitute for the cruiser Adler, which was destroyed by a hurricane at Apia four years ago. She was launched in the early part of last year, and was christened Kaiseradler, which name was changed later for the one she now bears. The Seeadler, like her sister ships, Condor and Kormoran, is of the improved type of the Buzzard class, and will be used principally for foreign stations. As she is rigged like a three-masted schooner, very powerful engines are not required. The highest speed she attains with 2,800 horse power is 16 knots an hour. The armament is modern and includes eight 10·5 centimeter guns and four revolvers. After the naval review the Seeadler will sail direct to Eastern Africa to relieve the cruiser Schwalbe. The command of the vessel was given to Captain Köllner, who was made famous by the taking of Valparaiso at the time of the Chilean insurrection.—*Illustrirte Zeitung.*

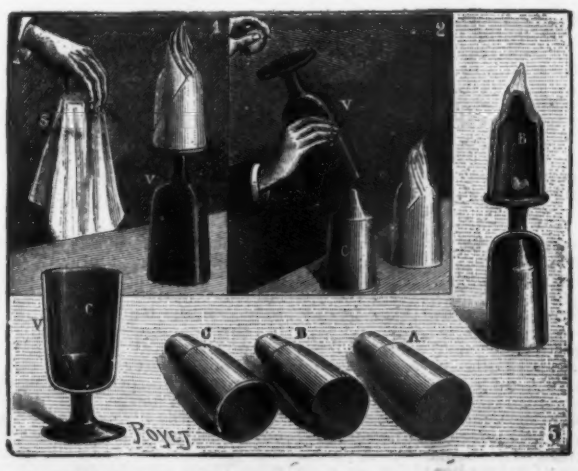
DISAPPEARANCE OF AN APPLE AND A NINEPIN.

To an apple and a ninepin, the principal objects with which this trick is performed, are added as accessories a napkin, a large vessel of dark blue glass and a cornet of coarse paper, which is made on the spot by moulding it over the ninepin.

First Disappearance (Fig. 1).—The apple, "in order that it may be more in sight," is placed upon the inverted glass, V, under the paper cornet, while the inverted ninepin is covered with the napkin, S, through which it is held. All at once the napkin, quickly seized by the two corners, is vigorously shaken and the ninepin has disappeared, or, rather, it is found upon the glass in place of the apple, which has passed into the prestidigitator's pocket.

Second Disappearance (Fig. 2).—The apple, first placed upon the table, is thrown invisibly toward the paper cornet, under which, in fact, it is found. And the ninepin? The prestidigitator "had forgotten" to tell it where it was to go when he sent the apple in its place. As he gives up trying to find it and seizes the blue vessel in order to put it in place, it is seen that the ninepin, driven by the apple, has passed underneath.

Fig. 3 renders an explanation scarcely necessary. At the moment that the paper cornet was made, the ninepin, A, was covered with a dummy, B, of thin metal, which remained in the cornet when the latter was removed. In the napkin, formed of two napkins sewed together by their edges, was concealed, between the two fabrics, a small disk of cardboard of the same diameter as the base of the ninepin. The latter was allowed to fall secretly behind the table into a box lined with silk waste, only the cardboard disk being held, thanks to which the napkin preserved the same form that it possessed when the ninepin was beneath it, as shown in Fig. 1. There is no need of explanation in regard to the apple that comes out of the prestidigitator's pocket and which is similar to the one that remained on the glass and was hidden by the false ninepin that covered it when the paper cornet alone was removed.

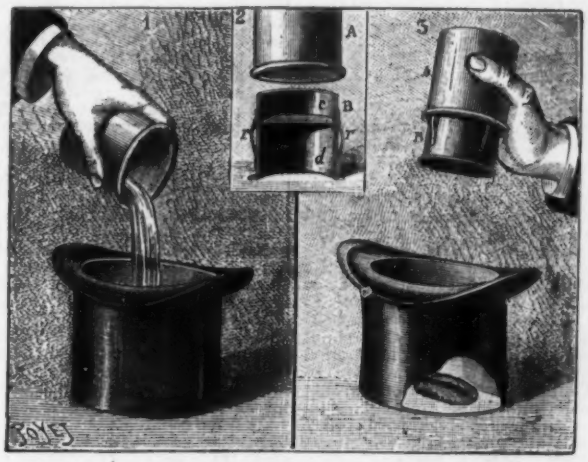


TRICK WITH AN APPLE AND A NINEPIN.

For the second disappearance, the apple, placed upon the table, is surrounded by the two hands of the prestidigitator, who, while it is thus concealed, by a blow given with the little finger of the right hand, sends it rolling on to a shelf behind the table. His hands, nevertheless, preserve the same position as if they held the apple. It is the first one that is seen upon the foot of the glass, the false ninepin being removed this time with the paper cover. Under the glass there is a second false ninepin, C, of metal, painted dark blue in the interior and which has a narrow flange through which it rests upon the edge of the glass, of which it seems to form a part. Fig. 3 shows it in section with the glass, and also the different pieces as they are arranged at the beginning of the experiment.—*La Nature.*

A BRIOCHE BAKED IN A HAT.

THIS old trick always amuses the spectators. Some eggs are broken into a porcelain vessel, some flour is added thereto, and there is even incorporated with the paste the egg shells and a few drops of wax or stearine from a near-by candle. The whole having been put into a hat (Fig. 1), the latter is passed three times over a flame, and an excellent brioche, baked to a turn, is taken out of this new set of cooking utensils. As for the owner of the hat, who has passed through a state of great apprehension, he finds with evident satisfaction (at least in most cases) that his head gear has preserved no traces of the mixture that was poured into it.



A BRIOCHE BAKED IN A HAT.

Fig. 2 shows the apparatus employed by prestidigitators to bake a brioche in a hat. A is an earthen or porcelain vessel (it may also be of metal) into which enters a metallic cylinder, B, which is provided with a flange at one of its extremities and is divided by a horizontal partition into two unequal compartments, *c* and *d*. The interior of the part, *d*, is painted white so as to imitate porcelain. Finally, when the cylinder, B, is wholly inserted in the vessel, A, in which it is held by four springs, *r*, *r*, *r*, *r*, fixed to the sides, there is nothing to denote at a short distance that the vessel, A, is empty, just as it was presented at the beginning of the experiment.

The prestidigitator has secretly introduced into the hat the small cake and the apparatus, B, by making them fall suddenly from a bracket affixed to the back of a chair. That at least is the most practical method of operating.

The vessel, A, about which there is nothing peculiar, is, of course, submitted to the examination of the spectators. The object of adding the flour is to render the paste less fluid and to thus more certainly avoid the production of stains.

The cake being arranged under the apparatus, B, in the space, *d*, the contents of the vessel, A, poured from a certain height, fall into the part, *c*, of the apparatus; then the vessel, gradually brought nearer, is quickly inserted into the hat in order to seize therein, and at the same time remove, the receptable, B, with its contents and leave only the cake.

Fig. 3 shows this last operation. We have intentionally shown the part, B, projecting from the vessel, A, but it will be understood that in reality it must be inserted up to the base at the moment at which the vessel, A, introduced into the hat, is concealed from the eyes of the spectators. The prestidigitator none the less continues to move his finger all around the interior of the double vessel as if to gather up the remainder of the paste, which he makes believe throw into the hat, upon the rim of which he even affects to wipe his fingers, to the great disquietude of the gentleman to whom it belongs.

The experiment may be complicated by first burning alcohol or fragments of paper in the compartment, *c*, of the apparatus. Some prestidigitators even add a little Bengal fire. But let no one imitate that amateur prestidigitator who, wishing to render the experiment more brilliant, put into the receptacle such a quantity of powder that a disaster supervened, so that it became necessary to throw water into the burning hat in order to extinguish the nascent fire.—*La Nature.*

[FROM THE NATIONAL GEOGRAPHIC MAGAZINE.]

THE DISCOVERERS OF AMERICA.*

By GARDINER G. HUBBARD.

IT is appropriate that we should take as the theme of our annual address for the year 1892 the discoverers of America.

The discovery of America was the work, not of one explorer, but of many, carried on during a long series of years, beginning with the Northmen, continued by Columbus, Vespucius, Magellan and Drake, and ending only with the nineteenth century.

Before we speak of the discoverers let us hastily review the condition of the old world prior to the discovery of the new.

Two thousand years ago philosophers generally believed the world to be round, and the most noted of ancient geographers, Eratosthenes, computed its circumference at 25,200 geographic miles. The true figure is 21,600 geographic miles or 24,899 English miles.

Ptolemy, two hundred years later, estimated it at 18,000 geographic miles and made a series of twenty-six maps showing the equator and the zones north of the equator, with parallels of latitude and meridians of longitude. As his base line was too short and his knowledge of places was generally derived only from seamen who had no accurate means of determining distances, his maps, though showing most of the countries of Europe, Asia and northern Africa, were inaccurate and unreliable, though vastly superior to those of a later date. These maps were either entirely lost sight of or so changed by the pictorial extravagances of the map makers of succeeding ages as to be of little value.

St. Augustine, Thomas Aquinas and other fathers of the church believed the earth to be a vast plain. They said with Isaiah that the heaven which embraces the universe is a vault; with Job, that it is joined to the earth; and with Moses, that the length of the earth is greater than the breadth. This they insisted was the teaching of the word of God and must be accepted. Those who believed that the world might be round declared that there could be no inhabitants on the other side, for that Christ said "All tribes of the earth shall see the Son of Man coming in the clouds of heaven with power and great glory."

The famous bull of Alexander VI., published in 1493, which gave all newly discovered land one hundred leagues west of the Azores to the Spaniards and all east of that line to Portugal, implied that the earth was a plain.

For 1,500 years science and the church were in opposition as to the shape of the earth, and there were very few, whatever might be their convictions, who dared question the infallibility of the church. Thus all progress in natural science was checked, and geography and map making practically ceased to exist.

Early in the fourteenth century Marco Polo's book of travels appeared. This greatly increased geographic knowledge and had a direct and strong bearing on the discovery of America.

In the preceding century the father and uncle of Marco Polo, merchants of Venice, made two journeys to the court of the great Khan Kublai, in Eastern China. On the second journey Marco Polo accompanied his father and uncle. They went by Persia, over the Pamir mountains, through Turkestan, across the great desert of Gobi, and through Mongolia to China. There they resided for many years, sent by the Khan on several missions and occupying important positions. On their return they sailed through the China Sea and Indian Ocean to India, stopping at the Philippine and Spice Islands, Sumatra and Ceylon; from India they traveled by land through Persia and Asia Minor, and by the Black and Mediterranean Seas to Venice. Soon after his return Marco Polo was taken prisoner by the Genoese, and during his captivity wrote an accurate description of the countries through which he traveled and in which he had lived so many years, and of the island of Cipango or Japan, with its inexhaustible riches of gold and pearls, 500 miles east of China. He also described the voyages of the Chinese to the islands of the Pacific, to Ceylon and to India, and of the rich trade carried on by the Mohammedans between the Spice Islands, India and the Mediterranean. These travels became gradually known to geographers, and in the fifteenth century gave a new impulse to geographic study.

* Presidential address before the Society, January 13, 1893.

About the same time the old maps of Ptolemy, which had been hopelessly obscured by the graphic fancies of the cosmographers of the dark ages, were, with his writings, brought from the East to Italy. The maps of the dark ages showed the Mediterranean and the countries around it, Arabia, Persia, Media, Gog and Magog, and a little of northern Africa, but so vaguely and incorrectly that to-day one would scarcely recognize these countries on existing maps.

Toscanelli, an Italian, prepared a map about 1474, taking the travels of Marco Polo as his guide. On other maps Cathay, or China, had been delineated as east of Europe; Toscanelli's transferred it to the west. His map shows the Atlantic Ocean, Cipango 100° west of Europe, and still further westward, Cathay. He sent a copy of this map to the King of Portugal, and subsequently another to Columbus, urging him to make his contemplated voyage to "The land where the spices are born, where the temples and royal palaces are covered with planks of gold."

Let us consider the condition of Europe at the time of the voyages of the Northmen to America, and the great changes which were gradually preparing the way for the colonization of America.

For nearly one thousand years B. C. the ships of Tyre and Sidon, Alexandria and Greece, sailed through the Mediterranean into the Atlantic Ocean as far as Britain. The early sailors were more adventurous and their ships more seaworthy than those of Columbus, but as the mariner's compass was not known, they rarely ventured out of sight of land.

When Rome became the imperial city, commerce, as well as dominion and authority, centered in Rome, and with her decline and fall shipping and commerce disappeared from the Mediterranean.

Then, far away in the north on the Baltic Sea, the Northmen began to sail the ocean, not for discovery or commerce, but to plunder and ravage richer countries than their own. The vikings became noted as bold rovers of the sea, pillaging every country they could reach by water. Sailing southwestward, they landed on the coast of France and made a permanent settlement in Normandy. They coasted along the shores of France and Spain, plundering as they went; passing the Pillars of Hercules into the Mediterranean, they ravaged the coast of Italy and established colonies in southern Italy and Sicily. Sailing westward, they conquered and colonized the eastern coast of England and Scotland, the Shetland, Orkney and Faroe islands and from these islands, in A. D. 850, they sailed 300 or 400 miles northwestward to Iceland, where they made settlements which have continued until our day. One of the early settlers of Iceland was driven by adverse winds to Greenland, where he was compelled to winter, returning in the spring with an account of his discovery. About 986, Eric the Red, an outlaw, fled from Iceland with a few friends to Greenland. Prevented by the icebergs from landing on the eastern coast, they sailed around Cape Farewell to the western coast where they founded two small colonies near Juliansburg, which existed for four hundred years until, forgotten and neglected by the mother country, overcome by want and hunger, they succumbed to the climate and the attacks of the Eskimo. Shortly after Eric had colonized Greenland, Bjarni, another Northman, sailing for Greenland, was driven by northeasterly winds continuing for many days far southwestward, to a land covered with dense woods. There is every reason to believe that this was America, and that Bjarni was its first discoverer. It was not the land of ice and glaciers he was seeking, so he sailed northeastward again, and in ten days reached Greenland.

Leif Ericsson, one of the Norse vikings, hearing of this land of woods, about the year 1000 sailed from Greenland in search of it. Passing the barren coasts of Labrador and Newfoundland, which he called Helluland, his party reached Nova Scotia, or Markland, and sailed southward to a place where they found grapes, and hence called it Vineland. They were surprised at the length of the winter days, which were nine hours long. The natives they described resembled our Indians and not the Eskimo of northern latitudes, and from these statements and the calculation of latitude from the length of the day, it is believed that it was New England. There they founded the colony of Norumbega, but after a few years it was abandoned, as the settlers were unable to withstand the attacks of the natives. All original records of the discovery of Vineland have perished, and our present knowledge is derived from the sagas of the Northmen, written at least one or two generations after Vineland had been abandoned. These legends bear the impress of truth, and there is no reasonable doubt that Leif Ericsson is a real character and Vineland his discovery. The sagas were lost or laid away and forgotten in the libraries of Norway and Sweden. In our day some of them have been unearthed, and we know more of the work of Leif Ericsson and his Northmen than was ever known before.

This discovery was not known beyond Greenland and Iceland except to a few men in Scandinavia, for this was the darkest age in the history of Europe.

When the Northmen were making their settlement in Greenland, Peter the Hermit appeared in southern Europe, mustering his forces for the first of those crusades which in their ultimate results accomplished a work of vastly greater importance than the redemption of the holy places from the Mohammedans. The transportation of pilgrims to and from the Holy Land gave employment to the ships of Venice and Genoa and restored commerce to the Mediterranean. Their vessels brought the treasures of the Orient and the science and art of Greece and Asia Minor to Venice and Genoa, whence they were distributed through Italy and Europe. The feudal system was broken down and the renaissance brought in. Europe awoke from the long sleep of the dark ages to new life and energy; progress in art and science became rapid, and the world entered upon an era of invention and discovery.

By the middle of the fifteenth century, Brunelleschi had finished the Duomo at Florence, where Savonarola was preaching and Michael Angelo was studying. Faust and Gutenberg were inventing movable types at Frankfort, upon which the Bible—the first book ever issued from the printing press—was printed. Gunpowder and the mariner's compass were just coming into use in European countries, though both had been discovered earlier.

In England, the Wars of the Roses were over. Henry VII. was king, and with him the reign of the Tudors and the prosperity of England commenced.

In Spain, Ferdinand and Isabella were preparing for that war with the Moors which resulted in their expulsion from the Spanish dominion.

In eastern Europe, the Turks had a short time before captured Constantinople and destroyed nearly all the commerce of Venice and Florence, and were now raising an army to ravage Austria and Hungary.

In Portugal, Prince Henry the Navigator was making those voyages to the coast of Africa for discovery and trade which made Portugal for one hundred and fifty years the greatest maritime nation of the world. Each year these expeditions sailed further and further southward, passing the Gold coast, the equator, the river Congo. They sailed out into the ocean and rediscovered the Azores, Madeira and the Canary Islands, formerly known to the Phenicians. In 1442 their ships brought home African negroes to be sold as slaves in Lisbon, the beginning of the African slave trade. In 1486 Diaz rounded the southern extremity of Africa and called it the Stormy Cape, though Prince Henry named it the Cape of Good Hope. Greater discoveries were made during the lives of men contemporary with Columbus than in all times previous or subsequent.

Columbus is for us the principal figure in this new world. He was born in Italy about 1446, though we know with certainty neither the place nor time of his birth and but little of his early life. He followed the sea for many years, sailing to Africa, England, and probably Iceland. About the year 1470 he is found in Portugal, where some say he was shipwrecked on the coast while on a piratical voyage. Here he married a Portuguese lady, whose father had been governor of one of the islands off the coast of Africa; and there he resided for several years, making maps and pursuing those studies which fitted him for his great voyage of discovery. He knew that the spices from the islands of the Indian Ocean, the silks, diamonds and pearls of India, were carried by the Arabs through the Red Sea or up the Euphrates in boats and thence by caravans to the Mediterranean and Black Seas, where they were exchanged with the merchants of Venice and Genoa for the goods of Europe.

He was convinced by the study of Marco Polo not only of the wealth of Cipango and Cathay and of the great trade between the Orient and the Mediterranean, but also of the possibility of reaching those countries and obtaining that trade for Spain by sailing west rather than by circumnavigating Africa. The actual distance from Europe in a due west line to Cipango is nearly twelve thousand miles; Toscanelli estimated it as 100° or nearly five thousand miles, but his map showed islands on the route which would reduce the distance between any two lands to about 2,000 miles.

Columbus was a devout Catholic, holding to the teachings of the church. In the book of Esdras he read that God on the third day of the creation made the earth, six parts of land and one-seventh water. He knew the vast extent of the Atlantic north and south, and reasoning from these facts, he thought it could not be over 2,000 or 2,500 miles to Cipango, though he actually sailed 3,230 miles before he reached a new world.

After Columbus determined to cross the Atlantic he applied for help to the King of Portugal. He wrote: "They took my charts and writings from me, saying they would ponder them, but secretly they sent out the ships they had denied me. God drove them back on their own coasts and punished their treachery, but I could no longer trust them." He therefore left Portugal for Spain. Las Casas describes him at this time as a man of noble and commanding presence, tall and well built, with a ruddy complexion, keen, blue-gray eyes that often kindled, while his waving white hair made him quite picturesque; his manner courteous and his conversation charming. He had an indefinable air of authority, as became a man of great heart and lofty thoughts. It was this commanding presence which enabled him to stand before Ferdinand and Isabella as their equal.

In 1484 he arrived in Spain a foreigner, poor and in debt. A stranger and friendless, he appeared at the court of the proudest sovereigns of Europe. Yet such was his bearing and the effect produced upon the king and queen by his eloquence that they appointed several learned men to consider his project. Some few believed, many remained in doubt, but most laughed at him as visionary and ridiculed his proposals as the dream of a madman. Those that were convinced by his reasoning became his firm friends. For seven years he waited patiently at the court, renewing his suit from time to time, until Grenada was conquered, when Isabella had promised to listen to him. A man less confident, less in earnest, would have succumbed before the many difficulties and delays he encountered. Again he applied to Isabella, and she agreed to equip a fleet. Columbus demanded that he should be made high admiral of the western seas and viceroy and governor of all the continents and islands which might lie therein, and that he should receive one-eighth of the net profits from all trade with such countries. Isabella refused, but Columbus, knowing that the discovery of a new and shorter route to the Spice Islands would give Spain the control of their trade, and realizing the power and wealth that would accrue to the Spanish throne through such discovery, insisted on his demands, and for this great constancy and loftiness of soul Las Casas commends him.

After this refusal Columbus mounted his mule and started for France, but was soon recalled; he returned to the court, which agreed to his demands. A patent was granted appointing "Christopher Colon, as soon as he shall have discovered said islands or mainlands in the ocean sea, or any one of them, to be our admiral of the ocean sea, viceroy and governor, in the said islands or mainland: I the Queen; I the King."

The fleet of Columbus was three small vessels: the largest a single-decked ship 90 feet long, the others with decks only in the stern and prow. His crew was 90 men. On August 6, 1492, they sailed from Palos, and on October 21 discovered the Indies. Columbus returned to Spain and appeared at the court of Isabella with his train of Indians bearing gold, silver, precious stones and other products of the islands he had discovered. It was Cathay and the shorter route to the Indies he supposed he had found, though he did not find the cities and rich countries, the gold and silver, the pearls and jewels that he sought. He thought these treasures lay further westward, and that he must find the straits of Malacca, and through them sail to the Spice Islands and India; and for that purpose he sailed on his second voyage, and after following the coast of Cuba 1,000 miles, believing he had found the continent of Asia, returned to Spain.

Ferdinand and Isabella gave many persons the right to visit the new-discovered lands, as was their prerogative, but they also appointed governors over the land and water, contrary to their agreement with Columbus.

On his third voyage, in 1498, he reached South America, the first European to discover that continent. He found a large bay and thought he had reached the straits; but, alas! the waters were fresh—it was only the Orinoco River. He coasted for some distance along the shore of the Caribbean Sea still looking for the straits, and then set sail for Hispaniola (or Cuba), where he had left his brother governor. On arriving he found his brother deposed and imprisoned. Columbus himself was put in chains and sent home. The captain of the vessel offered to remove his chains, but he refused, saying that they had been put on by order of the king and could be removed only by him.

While Columbus was vainly searching in the new world for the Orient, Vasco de Gama found it for Portugal, in 1497, by sailing around the Cape of Good Hope and crossing the Indian Ocean to India and the Spice Islands. He returned to Lisbon bringing all manner of precious stones, silks and satins, and spices of every kind. Columbus for the time was forgotten, and it was only after a long detention that he was permitted again to sail toward the western world.

On his fourth and last voyage Columbus landed at Honduras, followed the coast of Nicaragua and the isthmus of Panama, and then sailed along the Caribbean Sea, vainly searching for the straits that would lead him to the promised land.

On his return from this voyage the queen, his friend, was dead, and the last eighteen months of his life were spent in poverty and sickness at Valladolid, where he died in 1506, so little known that the local records of the city, which gave many insignificant details, make no mention of his death.

After Columbus had opened the way it was easy for other navigators to follow where he had led. Two other Italians, John Cabot and Sebastian, his son, sailed from England in 1497 nearly due westward for Cathay. They discovered Newfoundland, and sailed thence northeastward along the coast of Labrador, and were probably the first discoverers of the continent of America. The next year they made another voyage to Newfoundland, and then followed the coast of North America southward, probably reaching the Carolinas. These voyagers, still seeking Cathay and the Spice Islands, cared little for a land of hills and rocks, where neither gold nor silver was found.

Two generations pass before we hear of any further English expeditions to the new world.

The most noted of the followers of Columbus was Americus Vespucius, like Columbus and the Cabots an Italian, a pilot of great reputation, sailing in the service of Portugal. In 1497 he sailed around the Gulf of Mexico, Honduras, Mexico and Florida, and thence along the coast of North America nearly to Chesapeake Bay.

On another voyage he sailed to South America, reaching it a little north of Cape Saint Roque. He followed the coast nearly to the mouth of the Rio de la Plata, taking possession of the country for the King of Portugal.

Vespucius knew that this country was south of every part of Asia, and therefore could not be a part of the world as then known; he realized that he had discovered a "new world." An account of this voyage was published in German, Italian and French, with the title in the French edition, "*Novus Mundus*." In a map published in 1514 it was called "America." Thus the name of Americus Vespucius was given to the new world, and he received the honor due to Columbus. It was said that "Columbus had discovered new islands, Vespucius a new world"—that world already discovered by the Northmen, then by Columbus, the third time by Cabot, and now by Americus Vespucius.

After Columbus, Magellan was the greatest of the discoverers of America. Born of a noble Portuguese family, he early entered the naval service and sailed to India, where for seven years he was employed on land and on sea in laying the foundation of the Portuguese empire. He gained a great reputation for his services, and returned to Lisbon. Disappointed in an application to the King of Portugal, he went to Spain, where Charles V. gladly received him and gave him the command of a fleet of five vessels, in which he set sail for India and the Spice Islands. Magellan, like Columbus and Vespucius, hoped to find a way to India through some strait dividing South America, or, failing in that, by sailing around the mainland.

He left Spain in 1518 for Brazil, sailing then southwardly along the coast to about 50° south, where he spent the winter. Three of his captains became discouraged, mutinied and determined to return. Magellan heard of their treachery. He summoned the leader to his vessel. On his refusal to obey, the officer bearing the summons plunged a dagger into the heart of the mutineer; at the same moment a boat's crew from Magellan's vessel mounted the deck, and the mutiny was over. The other mutineers were either hung or left to perish on the coast of Patagonia.

Early in the spring of 1519 the fleet set out again, one vessel having been shipwrecked, and found a channel which proved to be the long-sought passage to India. Three months were spent in exploring the straits of Magellan before they entered the Pacific Ocean. One of the vessels sent to explore a channel in the straits deserted and returned to Spain.

They sailed along the coast of Patagonia 400 or 500 miles, and then northeastward toward Cathay and the Spice Islands. The wind was light, the ocean was as calm and smooth as an inland sea, and they called it the Pacific Ocean. For months their progress was slow; their food failed; scurvy and sickness broke out. Finally they reached the Ladrone Islands and found the food and rest they so much needed. They then sailed for the Philippine Islands, where in a foolish affray with the natives Magellan was killed; but he had finished his work—he had circumnavigated the globe; he had reached the east by sailing west.

One of the three vessels which had crossed the Pa-

cific was abandoned and burnt in the Philippine Islands, another was lost in the Malaccas; the last, loaded with spice, returned to Spain and finished the most remarkable voyage on record. Of the 280 men who sailed with Magellan in September, 1519, only 18 returned in September, 1522. The cost of this fleet, with all its equipment, was about $20,000, less than one-half the cost of the steamer plying between Washington and Mount Vernon. The sale of the spices left a large profit to Charles V. and the merchants who had furnished the funds for the adventure.

The King of Spain gave to the heirs of Ferdinand Magellan for their coat of arms a terrestrial globe belted with the legend "*Primus circumdedisti me.*"—"Thou first encompassed me."

In 1513 Vasco Nunez Balboa, a Spaniard who had married an Indian princess, heard, from the natives, of the Pacific Ocean and of the land of the Incas, where gold, silver and precious stones abounded. On September 25, from the top of the mountains he looked down on the Pacific Ocean, the first European to behold it. He collected a few vessels on the Atlantic coast for a voyage of discovery to Peru, and, taking them to pieces, he carried them across the isthmus and launched them on the Pacific. Two thousand Indians, we are told, perished in this work. When nearly ready to sail he was recalled by the governor of Darien and beheaded.

After the death of Balboa, Francisco Pizarro, one of his followers, returned to Spain with an account of the land of the Incas, and in 1529 was made governor and captain general of this country, then called the province of New Castile, with leave to fit out at his own expense an expedition to conquer that territory. He left Panama with three ships, 180 men and 27 horses, but it was not until two years later that they landed in Peru and began that contest which resulted in the overthrow of the Incas and in loading with riches the meanest of Pizarro's followers. The civilization of the Incas, the highest type in America, was crushed.

The Spaniards soon after this conquest sailed still further southward, along the coast of Peru and Chili, even to the straits of Magellan.

Rumors of an eldorado beyond the Andes came to Pizarro. One of his followers, Orellano, was sent to cross the Andes and descend to the headwaters of the Amazon, but he could not find the promised land. His party, famished and decimated by the fatigue of the journey and unable to return to the Pacific, built a boat and floated down the Amazon River 4,000 miles, to its mouth.

Before the discovery of Peru by Pizarro, Sebastian Cabot, with a small Spanish fleet, in 1527, sailed up the Rio de la Plata to the great falls of the Parana. He found some silver and gold mines in Brazil and heard of the civilization and riches of the Incas of Peru, but was unable to cross the mountains to their country.

Thus within fifty years after the discovery of America, South America had been circumnavigated, its great rivers navigated, and the general features of the interior and its treasures of gold and silver made known to the Spaniards and Portuguese.

Some time before the conquest of Peru, the Spaniards heard rumors of the great city of the Montezumas. In March, 1519, Hernando Cortez, one of the most daring and able of the adventurous Spaniards, landed on the coast of Mexico with ten vessels, 600 to 700 soldiers, 18 horsemen and some cannon. He burnt his ships, thus cutting off all retreat, and then marched toward the city of Mexico. By his courage, address and strategy he conquered or made friends of several tribes of Indians hostile to Montezuma. He pushed onward to the city of Mexico, where he was received with great pomp by Montezuma and escorted into the city as his friend and guest. Soon after Cortez, learning that Montezuma was preparing to attack the invaders, visited him in his palace, and by persuasion and force took him to the Spanish quarters and kept him a prisoner. Some time later the Indians chose another king and attacked the Spaniards, but after a slight success were defeated with great loss. Then Cortez, having captured and fortified the city of Mexico, defeated the other tribes and subdued the whole country. He subsequently explored it to the Gulf of California and Lower California, on the other side of the gulf. He then returned to Spain, but was not received by Charles V. as he expected. Forcing his way to the royal presence, Cortez replied to Charles, who wished to know who the intruder was, "I am the man who has given you more provinces than your father left you cities." There is no tale in the history of the world more marvelous than the conquest of Peru and Mexico, when we consider the high culture and strength of the natives, the small number of Europeans engaged, the extent of the conquests, and the value of the treasures obtained.

The Spanish discoverers of America were men of marked ability, capable of enduring privations of every kind, prompt in action, prepared for every emergency, proud, brave and self-reliant to the verge of rashness, eager for adventures, cruel, unscrupulous and rapacious, of unbounded greed and ambition. They sought and found gold and silver in Peru and Mexico in such quantities as they had never dreamed of; the new world brought to Spain greater wealth and glory than Columbus ever expected to find in Cathay or the Spice Islands. Spain, it is said, drew from America during the sixteenth century seven hundred millions of dollars in gold and silver—a sum fully equal to ten times as much in purchasing power at that time as it would be to-day.

In the exploration of North America the Spaniards took little interest. "What need have we," they said, "of things which are common to all the countries of Europe—to the south, to the south for the great and exceeding riches of the equinoctial; they that seek riches must not go into the cold and frozen north."

The French, though they made some remarkable journeys in the continent of North America, furnished but one discoverer whom we shall notice, Jacques Cartier, a French navigator, who was appointed in 1534 by Francis I. to the command of two ships for exploring the district near the fishing grounds of Newfoundland. He sailed up the St. Lawrence and took possession of Canada for France, erecting a wooden cross with the inscription, "*Vive le Roy de France.*" In 1541 a settlement was made near Quebec, the commencement of the French colonization in Canada.

The English were far behind the Spanish and Portuguese in the exploration of America. Their first great voyagers after the Cabots were slavers, buccaneers and pirates. Their most noted commanders were John Hawkins and Francis Drake, who carried a cargo of negro slaves from Africa to the West Indies and sold them at an enormous profit. They there heard of the Spanish galleons bearing the treasures of Peru and Mexico to Spain, and of the cruelties with which English seamen, taken prisoners, had been treated. On their return, fleets were equipped and sent to the Gulf of Mexico to capture the treasure ships and avenge the wrongs of the English sailors.

The queen frequently furnished ships belonging to the royal navy; they were equipped by Raleigh and other English noblemen, and the prizes were divided between the crew, officers, nobles and queen, the queen obtaining the largest share. Sir Francis Drake, one of the boldest and most successful of these cruisers, on one trip overhauled and plundered over 200 vessels and pillaged towns and cities. Several times Philip II. of Spain demanded his surrender as a pirate, for during all this time the two nations were at peace; the queen hesitated and delayed, but never yielded to the demand. There and then the foundation was laid of the navy and seamen of Great Britain.

In 1577 Drake was summoned to a private audience with the queen, at which it was agreed that a fleet of five ships should be equipped, nominally for the Mediterranean but really for the South Seas, as the Pacific Ocean was then called, to capture the great galleons, the treasure ships of Spain; and that the queen should contribute 1,000 crowns to the cost. On August 20, 1578, Drake, with this fleet, reached the Straits of Magellan and sailed through them in two weeks into the Pacific. There they encountered long and terrific storms, which carried them far south of the straits. One of Drake's vessels had been broken up for fire wood, another swamped in his sight and the third deserted and returned to England.

On the fifty-third day of the tempest Drake found himself south of Cape Horn, where no other vessel had ever sailed. Here, according to all the maps, was the great Austral continent, which extended an unbroken land area from the Straits of Magellan to the Antarctic Pole; but he found only water—before him rolled the waters of the Atlantic and Pacific in one great flood. He walked to the end of the farthest island, lay down, and with his arms embraced the southernmost ground of the new world. Then the weather changed and all went well. He sailed along the coast of South America, captured Valparaiso, took all the treasures he could find, refitted and provisioned his ships, and sailed northward, taking treasure ships and plundering cities until his vessel could carry no more, although it was ballasted with silver and gold.

Instead of returning as he had come, Drake determined to seek and find the fabulous strait so long sought by Columbus, and by that channel to find his way home. He followed the coast from Central America northward to the latitude of Vancouver and took possession of the land for England, calling it New Albion; then, finding the coast still trending to the northwestward and the weather growing more and more severe, he gave up his attempt, landed at the harbor of San Francisco, refitted his ships, and returned home by the Cape of Good Hope, reaching Plymouth in September, 1580, the second man to circumnavigate the world. What his reception would be at home was questionable. The news of his exploits had reached Spain the year before, and the ambassador of Philip demanded that he should be executed as a pirate, and renewed the demand as soon as he heard of the explorer's return. The result of this demand was for some time doubtful; but when it was heard that a Spanish hostile fleet had landed on the Irish coast, the queen determined to support Drake and receive her share of the spoils. What they were we are not told, but they must have been very great, as Drake's share was £10,000, equal to $400,000 of our money to-day. This voyage of Drake completed the discovery of America from the northern coast of Labrador southward around Cape Horn and northward to 48°, the latitude of Vancouver Island.

Nearly 100 years elapsed from the first voyage of Columbus to the voyage of Drake, each of whom vainly sought a way through America—the one from the Atlantic to the Pacific, the other from the Pacific to the Atlantic.

Thus, before the end of the sixteenth century the whole continent of America, save the Arctic border, had been circumnavigated and the southern part of it colonized; but it was not until after another century and another age that another race found homes for themselves on the coast of North America.

The voyages of the discoverers of America gradually became known to the public. It is interesting and instructive to examine the early maps representing these voyages to see how slowly the geography of the new world became known.

On the Zeni map of 1400, published in 1558, Greenland is connected with Norway. The same connection is shown in the Claudius Clavus map of 1427, in the Portuguese mappemonde of 1490, and even in the Ptolemy map by Waldseemuller in 1513; while in the map of Europe at the end of the "Chronicon Nurembergense," 1493, Greenland is shown as an isthmus connecting Norway and Sweden with Russia.

One of the first maps drawn after the discovery of America was that made in 1500 by Juan de la Cosa, a celebrated pilot and cartographer who accompanied Columbus on his first and second voyages and Vespucius on his first voyage. It delineated parts of the eastern coasts of South America and North America, showing by the flags of Spain, England and Portugal the coast explored by the ships of each country. On that part of the map between North America and South America, Columbus is drawn as Saint Christopher bearing the Christ child on his shoulders. The figure thus fulfills a double purpose of honoring Columbus and covering the undiscovered portions of the continent.

On the Cantino chart of 1501–1502 South America is delineated as surrounded by water from about 30° south to the Isthmus of Darien, then Cuba, the West India Islands and the coast of North America from 37° to 54° north. There is no land connecting North America and South America.

On the Ruysch map of 1508, two years after the death of Columbus, Greenland and Labrador are connected with Asia. The new world appears as an island near the equator.

On the Lenox globe, so called, made about the year 1510, now in the Lenox Library in New York, South America is a large island, while North America is represented by a number of detached islands.

On the map attributed to Leonardo da Vinci, 1514, the name "America" appears for the first time, and is given to a large island on the equator. Florida is the name of another island northwest of "America."

On the Schoner globes of 1515 and 1520 North America and South America are two islands, while the southern part of "America" is separated by straits from an Antarctic continent, and on the globe of 1520 the city of Mexico is identified as the Quinsay of Marco Polo. On the Hauslab globe of 1516–1517 the name "America" is given to South America. Straits connecting the Atlantic and Pacific oceans separate North America from South America.

On the Maiollo map of 1527 South America, including the Isthmus of Panama, appears an island separated by the "Straito Cubitoro" from North America. On the Munster map of 1532 South America is an island with a strait between it and Cuba, leading into the Pacific Ocean, while on the Munster map of 1540 North America and South America are connected by an isthmus.

On the Paris gilt globe, about 1525, Greenland is an island, Labrador and "Terra Florida" form parts of Asia, while the Gulf of Mexico is fairly delineated, with Cathay on its western shore. The Schoner globe of 1533 is much the same in the middle latitudes, while the Paris wooden globe, about 1535, represents Greenland, Labrador and Florida as belonging to Asia, the Gulf of Mexico as the "M[are] Cathairum," and South America as a peninsular extension of the Asiatic mainland.

On the map of Orontius Finæus, 1537, thirty years after the death of Columbus, Greenland is an island, Labrador and the coast of North America are attached to the northern part of Asia, Cathay appears on the Gulf of Mexico and South America is connected with the southeastern part of Asia. This map was made nearly twenty years after Magellan had circumnavigated the world.

On the Gastaldi carto marina of 1548 Greenland is connected with Norway on the east and Labrador with America on the west. North America and South America are connected, and the Austral continent is shown south of the Straits of Magellan.

There was no map published until after the sixteenth century that gave a correct delineation of the sea coast of America. It is no wonder that Columbus never comprehended the nature or extent of his discoveries. The more we study the history and geography of the times, the influence of the church, the difficulty of determining longitude, the ignorance of the movements of the mariner's compass and of the distance to Cipango, the greater will be our admiration for Columbus. Yet a recent writer speaks of the discovery of Columbus as a blunder, and others say, as if in disparagement of his work, that he knew of the discoveries of the Northmen and was only following their track; that the chart of Toscanelli which Columbus took on his first voyage indicated clearly his route; that Columbus died in the belief that he had discovered Cipango and Cathay, never realizing that it was the new world, and that Americus Vespucius is entitled to the greater credit.

Let us hear the opinion of a contemporary of Columbus, Sebastian Cabot: "When news was brought that Don Christopher Colon, the Genoese, had discovered the coasts of India, whereof was great talke in all the court of King Henry the VII., who then reigned, all men with great admiration affirmed it to be a thing more divine than humane to saile by the west into the easte, where the spices growe, by a chart that was never before knowen."

It is very doubtful if Columbus knew anything of the voyages of the Northmen, nor would such knowledge have been of much value, for Greenland was then believed to be a part of Europe and joined to Norway. If Columbus had known of the discoveries and sought the countries they had found, he would have sailed northwestward instead of westward.

Many before Toscanelli and Columbus believed the world to be round, and that by sailing westward Asia might be reached. Columbus not only believed but proved it. He made no blunder, for he sought land the other side of the Atlantic, and he found it. Vespucius knew little more than Columbus of the new world, and never realized that North America and South America were one continent. The maps show that learned geographers long after the discoveries of Columbus, Vespucius, Cabot, and Magellan did not understand the geography of the new world.

All voyages before that of Columbus had been coasting voyages, the sailors keeping in sight of land. Columbus pushed out into the unknown and trackless ocean, leaving the land far behind. Good seamen were unwilling to undertake so terrible a voyage. So convicts were obtained, liberated from prison on condition of sailing with Columbus. A brave, resolute, and self-contained spirit was necessary to command such a crew on such an expedition. New wonders startled him each day. The magnetic needle, instead of pointing steadily northward, swerved toward the west. The wind for many days blew unvaryingly from the east, and the sailors thought it would prevent them from returning. The Sargasso Sea puzzled them. They daily grew more timid as they sailed farther and farther into the ocean, though they had sailed much farther than they supposed. No voyage like that was ever made before and none like it can ever be made again, for the great discoverer solved the problem and reached the east by sailing west.

How like a tragedy the life of Columbus! Twelve years of preparation and waiting, five in Portugal and seven at the Court of Isabella; his demand; its rejection; his recall; his departure from Palos with three small vessels; his triumphant return after the discovery of America, admiral and governor; sent home in chains; his death, poor, unknown, and forgotten. Contrast this with what has recently taken place at Palos. Last September (1892) the greatest war ships of the world from Spain, Italy, Germany, Great Britain, and the United States, propelled by a power unknown to Columbus, escorted from the harbor of

Palos three little ships, two without decks, fashioned after the ships of Columbus.

At the time of Columbus' death none to honor him; now all Europe and the new world unite in rendering him the greatest homage ever paid to man!

FLIES IN CHOLERA.

By J. SAWTSCHENKO.

WHILE we already know from the researches of Celli (*Centralblatt f. Bakteriologie*, 1888, iv., 486) that the bacteria of tubercle, splenic fever, abdominal typhus, and European cholera pass unhurt through the digestive organs of flies, and reappear in their excrements without having forfeited their virulence, similar observations had until the present not been made with the bacteria of Asiatic cholera. The author's researches in this direction have supplied the deficiency and led to the following results: In the intestines of flies which had been fed on cholera cultures, the bacteria of cholera were easily recognized after periods of twenty-four, forty-eight, seventy-two, and in one case ninety-six hours. In the contents of the intestines of flies, which had been fed not with pure cholera cultures but with excrements, or with the contents of the small intestine of patients who had died of cholera, Koch's cholera bacteria were still to be distinguished after twenty-four, forty-eight, and seventy-two hours along with other bacteria to be met with in the material used for infection. The cholera bacteria obtained from the intestines of flies did not lose their virulence even after forty-eight to seventy-two hours. In view of these results the author takes up the question whether flies merely disseminate by their excreta the cholera bacteria which they have taken up or whether the bacteria do not at suitable temperatures and under suitable dietetic conditions of nutriment multiply within the digestive system of the flies. He considers the latter case as the more probable. Hence in this case the flies would not be regarded merely as disseminators of infections, but, in part at least, as its foci from which new, fresh generations of cholera bacteria perpetually arrive upon our food.—*Centralblatt fur Bakteriologie* and *Chemiker Zeitung.*

THE OLDEST PRESCRIPTION IN THE WORLD.

IN the course of a deeply interesting lecture delivered by Prof. A. Macalisher, M.A., M.D., F.R.S. (Professor of Anatomy, Cambridge), at Firth College, Sheffield, on "Studies in Ancient Egyptian Literature," some of the earliest medical writings were referred to and explained and translated by the professor. Photographs of soiled and seared papyri, together with the photographs of the mummified monarchs and magicians who wrote them, were depicted on the screen. Among the earliest prescriptions shown by the professor was one for a "hair wash," for "promoting the growth of the hair," for the mother of King Chata, second king of the first dynasty, who reigned about 4000 B. C.

It is as follows:

Pad of a dog's foot	1
Fruit of date palm	1
Ass' hoof	1

Boil together in oil in saucepan.
Directions for use: Rub thoroughly in.

Considering the non-hirsute nature of the ingredients used, one would imagine that homeopathy was in those bygone days carried even to a greater extreme than in later times.—*British and Colonial Druggist.*

CHLORALOSE.

By HANRIOT and C. RICHET.

THE authors have obtained excellent results by the use of "chloralose" as a hypnotic agent. Chloralose has already been described by Hefter (Ber. 1889, 1050), but the latter did not, apparently, obtain it in a state of purity. It may be prepared by heating to 100° C. for one hour a mixture of equal parts of anhydrous chloral and dry glucose. The mass is subsequently cooled, moistened with water, and extracted with boiling ether. The soluble portion is distilled 5 to 6 times with water in order to drive off all free chloral. The residue by fractional crystallization from water yields two bodies, "chloralose" (yield 3 per cent.) and "parachloralose." Chloralose ($C_8H_{11}Cl_3O_6$) crystallizes in fine needles, melting at 184°–186° C., and volatilizes without decomposition. It is slightly soluble in cold and fairly soluble in hot water. Potash does not liberate glucose from it, and with sulphuric acid and acetic anhydride it yields di- and tetra-derivatives respectively. Parachloralose forms nacreous plates melting at 229° C., with difficulty soluble, even in hot water.

Physiologically, chloralose possesses two, apparently contradictory, properties. It is hypnotic, and at the same time augments the excitability of the spinal cord. A dose of 2 to 3 grammes administered internally to a dog (weighing 10 kilos.) caused the animal after 10 to 15 minutes to stagger about and presently fall into a profound slumber, lasting several hours; but differing from the effects produced by chloral, in so far that reflex action was not abolished, but, if anything, exaggerated. A dose of 0·6 gramme per kilo. did not prove fatal, but only produced anæsthesia. The minimum dose required to produce a visible hypnotic effect was 0·02 gramme per kilo.

Landouzy and R. Moutard-Martin have employed chloralose during five months in the treatment of various maladies attended by persistent insomnia, and come to the following conclusions:

1. Chloralose may be administered without danger in doses not exceeding 0·8 gramme, and does not produce any digestive troubles, headache or toxic symptoms.

2. One gramme forms a strong dose; it is better to keep within the limits, 0·2 to 0·75 gramme. A dose of 0·5 gramme provokes a deep, calm sleep, even in those cases where recourse has been had, in vain, to other hypnotic agents.—*Comptes Rend.*

CROTALIDAE OF INDIA AND CEYLON.

THESE serpents are less venomous than their congener of North America—*Crotalus horridus* (rattlesnake).

Derivation of Crotalus is from Greek—κρώταλον (krotalon)=a rattle.

Peculiarities of Crotalus.

(*a*) Depression in boreal region.
(*b*) Broad, triangular head.
(*c*) Wedge-like tail, spined in genus Halys.

Venom.—Globulinic.

Symptoms.—Local swelling—nausea and fever.

Treatment.—Local destruction of venom with $K_2Mn_2O_8$.

There are four genera of these pit vipers:

First.—Trimeresurus; seven species; rarely fatal.

T. gramineus is perhaps identical with the grass adder of Ceylon.

Second.—Peltopelor macrolepis; occurs in India.

Third.—Halys; two species:

(*a*) Halys himalayanus.
(*b*) Halys elliotti.

"Halys is the only Indian genus with a vestige of the spiny caudal appendage of Crotalus horridus."—Fayrer.

Fourth.—Hypnale nepa, or Carawilla; a species of S. India and Ceylon.

Dangerous, but seldom fatal.

Amherst, Mass. W. D. MARSH.

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